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Control of European Corn Borer by Mechanical Means
C. O. Read

Effect of Seed Treatment on Wear and Accuracy of Drop in Corn Planters
B. Koehler and R.I. Shawl

Results of Adapting Explosives to Ditch Blasting Requirements
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Engineering Service for Farm Owners
L. J. Fletcher

Steel for Long Wearing Harrow Disks
A. H. Hoffman

Are Farm Buildings to be Considered an Expense or an Investment?
A Discussion

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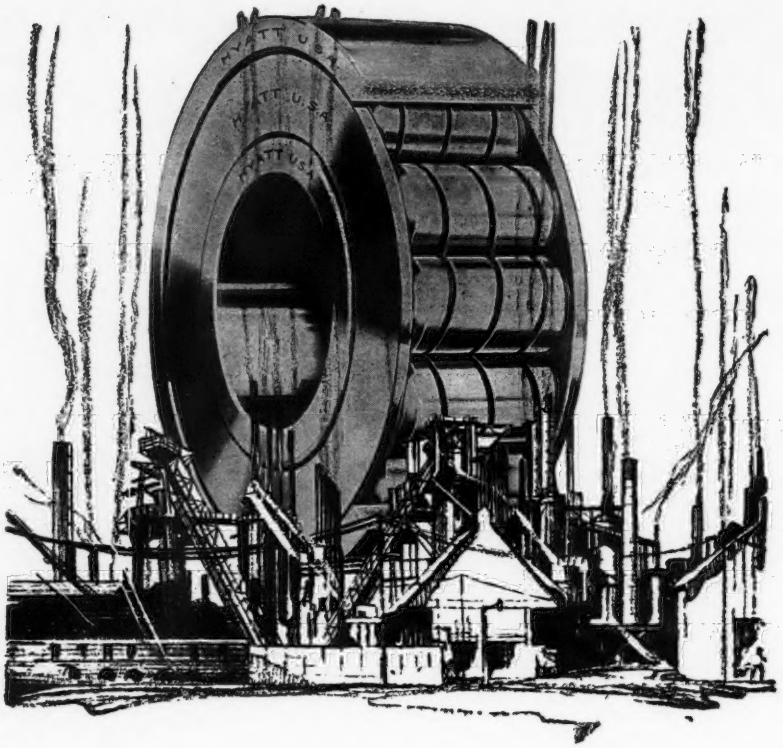

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AGRICULTURAL ENGINEERING

Vol. 9 FEBRUARY, 1928 No. 2

Corn Borer Control by Mechanical Means*

By C. O. Reed[1]

IT IS assumed that you are all aware of the seriousness of the menace of the European corn borer. Those who want more evidence on this point should refer to the quantity of literature now available on the subject. Suffice it to say that the results of the insect's ravages in Ontario are so far-reaching that it is difficult for us to comprehend them fully; that in 1926 commercial damage to the corn crop was felt in northern Ohio, and that the borer is now on its way to the hearts of the corn and cotton belts of this country.

Through the executive committee of the International European Corn Borer Organization an appeal for action was made by several agricultural factors to the President, to the Secretary of Agriculture and to the second session of the 69th Congress. That Congress appropriated ten million dollars "to enable the Secretary of Agriculture to apply such methods of eradication or control" as in his judgment might be necessary. This money was used to carry out what is now commonly called the "1927 Spring Clean-up Campaign." The purpose of that campaign was to determine whether concerted effort, under unified control and uniform procedure, could slow up the spread of the insect into new territory and hold the borer population below the point of commercial damage in territory already infested. The campaign was organized along three major lines of activity.

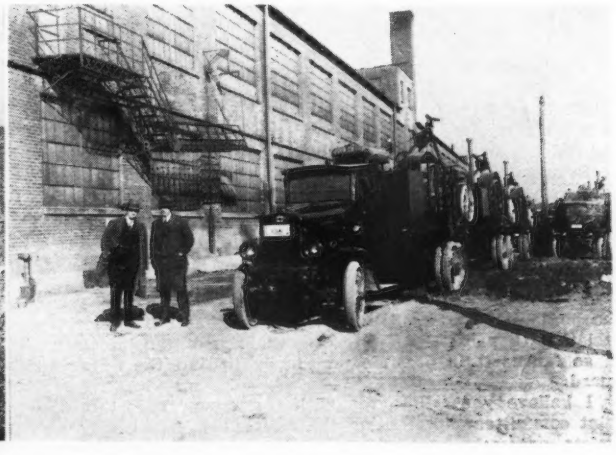
The educational work was carried on by the educational branch under the leadership of G. E. Farrell, of the U.S.D.A. agricultural extension service, assisted by state directors of extension, county agents, special assistant county agents, special demonstrators and college men. The publicity branch carried on the necessary publicity work under the direction of R. Brigham, of the federal extension service, assisted by the extension publicity men in the service of the various states concerned. The enforcement of the regulations, the actual clean-up work performed by the government, and "extra labor allowance" matters were under the jurisdiction of the operating branch which was under the control and able leadership of L. H. Worthley, whom you know as federal administrator of corn borer control. Besides being in direct charge of field operations, Mr. Worthley and some of his assistants acted in an advisory way in educational and publicity matters. Among others assisting Mr. Worthley in the operating branch were E. G. Brewer and H. N. Bartley, administrative officers in charge of districts, and Dr. D. J. Caffrey, federal entomologist on corn borer work. During the heat of the campaign it was the author's privilege to be in charge of the engineering and maintenance department of the operating branch and to be ably assisted in that work by R. B. Gray of the division of agricultural engineering, U.S.D.A. Bureau of Public Roads, who has succeeded me in the active supervision of that department.

Mention should be made, too, of the loyal support given the campaign by a number of Washington officials. The army assisted; the purchasing division carried a tremendous load at the beginning of operations; S. H. McCrory, chief of the U.S.D.A. division of agricultural engineering, assisted materially and is now acting in an advisory capacity; Dr. W. H. Larrimer is chief of the division of cereal and forage insects of the Bureau of Entomology, under which division corn borer regulations, operations and research fall; Dr. A. F. Woods and R. R. Kauffman acted as the personal representatives of the Secretary of Agriculture, the former being the head under which all corn borer activity was coordinated.

Mention of these larger divisions of the organization is made here to clear up some confusion that has existed in the past in the minds of some as to who was who and what was what in corn borer control work. When one grasps the larger phases of the work, the organization is really very simple. The various lines of work are sharply drawn, and definite, but the whole affair is big—it has to be in touch with 202,338 farms growing 2,506,005 acres of corn, to handle

*Paper presented at a meeting of the Power and Machinery Division of the American Society of Agricultural Engineers, at Chicago, November, 1927.

[1]Professor of agricultural engineering, Ohio State University. Formerly in charge (and now advisory) of engineering and maintenance, Corn Borer Control, Bureau of Entomology, U. S. Department of Agriculture. Mem. A. S.A.E.



(Left) Clean plowing helps—and it can be done. (Right) C. O. Reed and R. B. Gray, in charge of engineering and maintenance, conferring as equipment for the clean-up campaign leaves headquarters for the "battle front"

4000 field and road units, and to control, last June, nearly 7000 employees working in small units over an area of about 25,000 sq. mi.

How the organization was perfected quickly, the difficult problems confronting execution of the plan, just how the work was carried on, how the various states functioned, would compose an interesting paper. A review of these subjects, however, is not pertinent here; but it is assumed that you will be interested in a brief summary of the results of that campaign and in the present status of the borer problem.

RESULTS OF THE 1927 SPRING CLEAN-UP

Table I compares borer population for the three last years and gives averages for the entire 1927 clean-up area, exclusive of Indiana which had no infestation in 1925. These figures are secured by counts taken by scouts under the direction of Dr. Caffrey whose men counted approximately 1500 fields in 1925, 2000 fields in 1926, and 5000 fields in 1927. These counts, of course, are taken in the late summer and early fall.

TABLE I. Increase in Corn Borer Population Per Year for the Last Three Years

Item	Year	Percentage or number	Percentage increase or decrease: 1926 over 1925	Percentage increase or decrease: 1927 over 1926
Average percentage of stalks infested	1925	1.35		
	1926	3.23	+139.25	
	1927	5.50		+70.28
Average number of larvae per infested stalk	1925	1.56		
	1926	2.73	+75.00	
	1927	2.61		—4.39
Average total larvae per 100 stalks	1925	2.11		
	1926	8.82	+318.06	
	1927	14.34		+62.58

NOTE: Averages for the entire area are included in the 1927 clean-up with the exception of Indiana.

At the close of the clean-up period last June it was estimated by careful counts that the clean-up had been instrumental in the destruction of over 90 per cent of the larvae which existed in corn refuse the previous March. Evidently the clean-up has been effective, because, as shown in Table I, although there are more borers now than ever before, the rate of increase in population has been greatly reduced.

It must be remembered that this reduction in rate of increase has been accomplished under very adverse conditions. The agricultural engineers who assisted in drawing up the original program and procedure made this statement in their presentation: "As an engineering feat, the proposed clean-up is entirely possible and practical providing sufficient funds are available February 1, 1927, providing state laws are enacted to allow unhampered procedure, and providing weather conditions are not extremely unusual." We enjoyed only one of those three requisites. The money was not available until March 15, and the work had to be done through a season which not only was about the wettest spring known in the region, but also was one unusually favorable to the insect.

The accompanying map shows the area known to be infested through 1926. It also shows areas newly discovered this fall as infested with the borer. Entomologists ask us to use this phrase "newly discovered areas" in preference to the old term "spread."

Scouting for newly infested areas in 1927 was quite extensive and quite thorough, much more so than was possible in 1926. Leading authorities claim that, had the 1926 scouting work been as thorough as that of this fall, undoubtedly the known-infested areas of 1926 would have been a little larger and consequently the newly discovered areas of this year would be smaller. Probably some borers exist beyond the borders of the newly infested areas, but the authorities feel that they have gotten out to the rim of the infestation in so far as it is possible practically to find the advanced guard.

I believe you will agree with the recent report of the joint committee representing the national societies of agronomists, entomologists and agricultural engineers, which says "it is believed that the compulsory clean-up of 1927 not only greatly reduced the rate of infestation increase, but has been successful in preventing serious commercial losses, and that the expenditure of large funds for this purpose has been completely justified." Seldom is an insect pest attacked in such a large way and so much accomplished in such a short time. From start to finish, all of the field clean-up operations, much of the other work of the operating branch, and considerable of the educational activity was agricultural engineering pure and simple.

Although a little of the ten-million-dollar appropriation is left and is available until next July first, roughly the expenditures will approximate the following proportions:

43 per cent to farmers as "extra labor allowances"
3 per cent for educational and publicity work
31 per cent for operating costs, including all operating labor, overhead, fuels, oils, repairs, etc.
23 per cent for equipment and supplies.

An extra labor allowance of $2 per acre being allowed, a little over 4¼ million dollars were paid to farmers for the extra labor of clean-up they performed on 2,292,822 acres; this averaged about $1.86 per acre.

A state official recently remarked that he was glad to report that a large share of the money paid to farmers in his state was used by them to equip themselves to accomplish clean-up work more thoroughly and more efficiently. If this is true, does it not indicate an encouraging tendency from the standpoint of corn borer control? Evidently the federal government cannot continue long to support a program such as that of the 1927 clean-up. But the claim is being made that the government should support such a campaign through a two, three, or four-year period which will be a transition period in which the farmer is adapting himself and his farm practices to the new problem and equipping himself to carry the burden later alone.

If the work is to continue, and if the clean-up area next year is to include twelve counties of more than one per cent infestation in New York, three counties in Pennsylvania and all of the infested areas of Ohio, Michigan and Indiana, this entire area will include approximately 3½ million acres of 1927 corn ground.

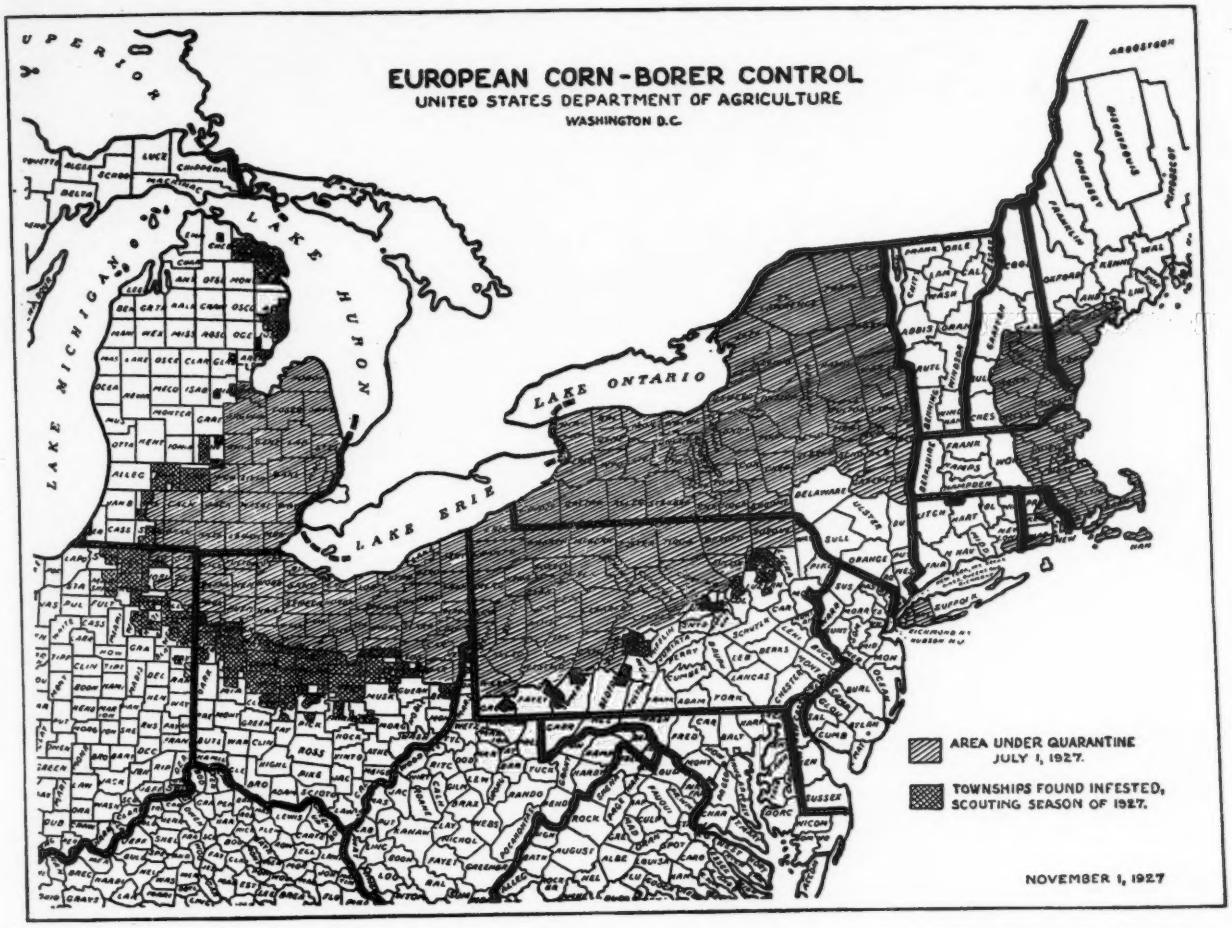
MECHANICAL METHODS THE ONLY MEANS OF CONTROL

Permit me to repeat the well-worn statement that the mechanical destruction of the larvae from harvest time until the following June is the only means of control yet known which can be applied generally and in a large way. Dean Curtiss recently remarked that the slogan "Learn to live with the borer" was dangerous because of its incompleteness. He suggests "Learn to fight the borer so that you can live with it."

Entomologists are the fundamental workers in corn borer control; they must keep us informed of the insect's nature and habits, of its vulnerable points for attack, and of the effectiveness of our attack. Agronomists, animal husbandmen, agricultural engineers, chemists, physicists, are working on ways and means of control. But the farm management experts—with their knowledge of the causes and effects of tendencies and changes in the farm program, with their viewpoint on costs—are the fellows who put the jig-saw puzzle together and hand us a challenge now and then.

C. R. Arnold, of the department of rural economics, Ohio State University, has just completed an extensive survey of the farmers' costs for the extra effort of clean-up necessary to meet corn borer regulations. With man labor at 30 cents, horse labor at 15 cents and tractor cost at $1.00 per hour, the average cost per acre to the farmer for the extra labor he had to put forth in 1927 was $2.91. The data were secured on 482 farms in nine Ohio counties and do not take into consideration the fact that about May 15 the regulations were lifted concerning debris remaining in fields then sown to smaller grain. In Lucas County, where the infestation was high and considerable hand work in picking up was necessary, the cost per acre averaged $6.10. Here is a challenge to agricultural engineering.

The farmer is not going to continue to grow corn long at this additional cost; nor is he going to be content long with the hand methods of peasantry. We must beat these costs down; we must substitute practical mechanical devices for hand methods if we are going to learn to fight the borer



in order to live with it. In other words, for a time, at least, the success of corn borer control depends upon how easy and how economical the agricultural engineer makes it for the farmer to control the pest.

It will be apropos to devote the remainder of this paper to a review of just where we are in the development of machinery for corn borer control; but I must confess the subject is so complex that I scarcely knew where to begin—and there is no end.

Methods of handling the corn crop vary widely, and properly so; each of these methods is affected by a variety of agricultural conditions strong in their dictates. The speed at which the problem must be attacked and the uncertainty of the future has upset normal development in corn machinery until a state of chaos exists out of which we must think our way with as sound and logical thought and with as great vision as we ever applied to any problem. The requisites to be met are severe. The farmer is in a position to change his machinery program only slowly; for a time he must use types similar to those of the present until some fundamental changes in the production of corn take place. Machinery, however, as well as the borer, can force those fundamental changes.

I believe that I can simplify the approach to the machinery discussion by dividing the subject into two main topics: 1. Present types of machines, their performance and development work on them; and 2. some suggestions pertaining to the future. Any criticisms that appear are made kindly and solely in behalf of corn borer control. Brevity will face the omission of details, and restraint may characterize these remarks at certain points to avoid violation of confidence with some manufacturers who have conferred with us and who ask that their plans not be made public at this time.

PERFORMANCE OF AND DEVELOPMENT WORK ON PRESENT TYPES OF MACHINES

Hand Corn Cutters, Corn Knives, Hoes. This subject will amuse some of you, but remember that there will be thousands of acres of corn cut by hand for some time to come in Ohio, and H. H. Musselman, of Michigan State College, can show you many acres in Michigan on which it is impractical to consider using a corn binder. Cutting very low with a hand tool is a problem to be solved. The latest development in this line is a short-handled implement similar to a hoe but carrying a very sharp blade of high quality steel, the cutting edge of which is curved to approximately a six-inch radius. This tool, made by a hand tool company, is pointing the way to progress in hand cutting of corn.

Cutting corn within two inches of the ground surface is of great importance to the farmer who is not going to plow, and should be emphasized even to the farmer who does plow, because, if his normal, subsequent method of handling the stalks kills the borers, the low-cutting operation is the only additional operation imposed by control. But the farmer who wants to disk in small grain in a field of high-cut stubble is confronting a hard problem, unless he can secure a tractor

TABLE II. Percentage of Borers Remaining in the Stubble When Corn Was Cut, at Varying Heights, from October 6-14

Height of stubble	Percentage of borers originally in the plant, which remained in the stubble
Cut at ground level	0.59
2 in.	1.00
4 in.	5.46
6 in.	9.87
8 in.	16.43
10 in.	21.07
12 in.	25.64
14 in.	34.16

and stubble pulverizer which require an additional field operation, and the use of the pulverizers on fields already sown to small grain does not take very well with farmers.

Table II shows data secured by Dr. Caffrey on corn cut between October 6 and 14 and gives the percentage of the total number of borers in the plant which remained in the stubble when the corn was cut at varying heighths.

Low-Cutting Attachments on Corn Binders. During the past harvest season the operating branch of corn borer control, cooperating with the educational branch, put on about two hundred demonstrations with low-cutting attachments using all three of the different makes of binders on the market which are equipped for low cutting. One of these binders carried a wide throat and had increased knife speed; the others carried narrow throats and about normal knife speed. Considering all tests under all conditions, 83 per cent of the stubble left by the wide-throat machine was 2 in. or less in height, whereas only 65 per cent of the stubble left by the narrow-throat machines was 2 in. or less.

Within a short time complete data regarding the performance of his particular machine, its troubles, weak points and strong points will be sent to each manufacturer and conferences will be sought leading to improvements for the 1928 season. During the past six months great progress has been made in low cutters. Evidently the wide throat and increased knife speed have demonstrated their superiority, and it is hoped that the problem is near solution. Corn borer control authorities, however, will welcome the day when the low-cutting idea is sold sufficiently to enable manufacturers to get away from the low cutter as an attachment and to build the device into the binder as an integral part of the original design.

In your consideration of low cutters remember that ground-level cutting is the objective; cutting higher than that is simply a toleration. F. Irons, in the corn borer control engineering department at Toledo, has devised a clever means of using a stationary knife to secure ground-level cutting. This knife is a simple attachment; the regular binder knife is left intact and in motion. A shield protects the stalks from being cut twice, but any weeds, grass or vines that start clogging are cut free by the regular reciprocating knife. This machine has given splendid results in the heavier soils, and those interested should inspect this new development. Just how it will perform in shallow-rooted corn in light soils is yet to be determined. In the past stationary knives and even disks have failed, partly because their pulling action dislodged the roots and led to hopeless clogging.

Field Ensilage Harvesters. If the field ensilage harvester carries a successful low-cutting device, and close to 100 per cent of the cut-off material passes through the cutter head, the implement has a real place in corn borer control not only for silage corn but also as a means of handling sweet corn stalks immediately after the sweet corn has been picked.

G. M. Merwin, of the International Harvester Company, did considerable testing on this type of machine in the infested region early the last harvest season. In one of these tests the machine was killing about 97 per cent of the borers; it was leaving about 3 in. of stubble; approximately 90 per cent of the entire bulk of the plant passed through the cutter head, and about 5 per cent of the plant dropped away from the machine as leakage. In another test the machine succeeded in leaving a stubble averaging 1.7 in. in height, with 13 per cent of the stubble over 2 in. and 87 per cent less than 2 in. Mr. Merwin then withdrew to make additional changes for corn borer work. Recently two of these machines carrying further improvements have been received at Toledo, and as further test work on them is now in progress no further report can be made at this time. The machines will be used also next spring on whole stalk fields to determine their possibilities for meeting that condition.

Stalk and Stubble Shavers. Although poling down stalks preparatory to raking and burning is the cheapest method, nevertheless there are some winters and some territories in which very few good poling days are to be enjoyed, and farmers are forced to use other methods of getting the stalks loose. Mowers are used to some slight extent, but the guards on the regular cutterbar give constant trouble in piercing the stalks, pulling them, and then clogging. This difficulty is overcome somewhat by raking with the row first, then burning the resulting windrows, then cutting with the mower in the direction opposite to that of the raking process. Weed bars with stub guards help greatly, but work of this kind is severe on a mower, troublesome, and costly in comparison to other methods of shaving.

Last winter was such a poor breaking winter that thousands of farmers were caught in March with fields of whole stalks which then had to be treated by some means of cutting the stalks loose. Many made homemade stalk shavers, using a rectangular sled, about 2½ by 6 ft., and attaching to this knives made by the local blacksmith from old landsides. These proved so successful and so badly needed that the subject has been given considerable attention by the authorities. E. A. Silver and R. D. Barden, of the department of agricultural engineering, Ohio State University, in cooperation with the engineering department at Toledo, are now improving sled cutters and they hope to have working drawings and descriptions of them ready for distribution to farmers in December. Their program includes the following:

1. A simple stalk shaver, easy to make. For the farmer who cannot afford much layout and who has not the ability to make a better machine. This will probably carry a stationary disk holding device.
2. A better and little more complicated stalk shaver. For the farmer who can afford perhaps a $20 layout and who has facilities for iron work. This sled will probably carry a disk steering and holding device, and adjustable knives.
3. A stubble shaver which will also gather the stubble.
4. Shavers for tractors. After the principles of 1 and 2 are determined, a study will be made of combinations for four or six-row use behind tractors.

These implements probably will use lister cultivator sweeps. Consequently, if manufacturers suddenly hear of a

(Left) Some of the old implements fail badly in the corn borer clean-up work. Under many conditions present hay rakes leave too much debris and force the farmer to hand picking. (Right) Agricultural engineers cannot let this sort of thing go on long

demand for these parts from the corn borer territory, do not conclude that the East has gone crazy, and please do not refuse to ship.

Rakes. This is one of the most difficult problems. To properly clean a badly infested field after the stalks have been raked and burned seems well nigh impossible with present equipment. Close-toothed, sulky-dump rakes help, but the whipping of the teeth threshes out much of the fine material which the close spacing picks up. C. H. Zirckel, of the International Harvester Company, conceived the idea of clamping the teeth together in pairs; this helps, but on rough ground there is leakage between the pairs. Attempts to wire teeth together have failed largely. The use of heavy gravel screen fastened to the teeth to form a basket has been tried with some success on smooth ground. Regular side-delivery rakes cannot stand the abuse of whole-stalk work and close work at the same time. Special heavy, close-toothed, side-delivery rakes have been suggested, but we are not informed of the latest developments along this line.

A farmer named Baker, of Paulding County, Ohio, made an ingenious attachment which he substituted for the regular tooth bar in a sulky-dump rake. The short, stocky, close-spaced teeth in this attachment had no play in any direction except the entire tooth bar raised intact for dumping. This device did excellent work on smooth ground, but it failed somewhat in hilled corn on rough ground. Some agricultural engineers who have seen this device ridicule it. Nevertheless Mr. Baker's principle of permitting no horizontal whipping of the teeth is worth watching. If these teeth can be given some vertical play, perhaps under spring pressure, the idea may find wide application. It is our understanding that R. H. Wileman, of the Indiana agricultural experiment station, is experimenting along these lines.

One large manufacturer contemplated considerable work on rakes this fall, using special shapes of teeth. Further information on how this work is progressing is not at hand.

It is hard for one who has not witnessed clean-up operations in badly infested territory to conceive of the difficulties encountered in satisfactorily cleaning a field preparatory to disking in small grain. The regulations permit no more than ten lineal feet of debris per square rod, and in some areas even this is not allowed. Of course the farmer's raking problem is solved somewhat by plowing, but there are large areas in Ohio, and there will be far larger ones in Indiana, Illinois, and Iowa, where plowing in the spring for small grain is often impossible.

Permit me to state now and repeat later that one of the great needs at present is some mechanical means whereby a farmer can finish a field and have it pass inspection before he disks in small grain.

Stubble Pulverizers. The eight hundred stubble pulverizers used by the government last spring were a very necessary type of implement, and we feel that they gave excellent service. The upkeep cost is rather high. This, however, is not due to major faults in design or construction; it is due mainly to the severe external conditions which a machine of this kind must meet. There is opportunity for improvements in the pulverizer. Full information is in the hands of the manufacturer who is making these improvements and who will tell you of them if he cares to.

To date we have not thought it advisable to use the pulverizer on stubble over 10 in. in height. H. P. Clay, of the department of engineering and maintenance, is carrying on a number of field tests on pulverizers to determine mortality at different heights of stubble, the effect of speeds, the effect of wear on blades, and the effect of leaning stubble. These tests are being run on different soils and under a variety of conditions. The results are not yet ready but will be made public at the earliest possible moment.

Properly operated, and used under the conditions for which it is designed primarily, the stubble pulverizer has an important place in corn borer work and probably will have for some time to come. From the standpoint of costs, however, it should give way to the low-cutting operation. Farmers who do custom work with pulverizers are getting from $1.25 to $1.50 per acre.

Warning should be given that the two-row stubble pulverizer must be furnished with plenty of power. Unless his stubble beating conditions are ideal, the man using a 10-20-hp. tractor on a pulverizer will have to favor his tractor and sacrifice effectiveness.

Plows. This subject is more complicated than difficult; it is deceptive and will bear watching. Of course, you are all familiar with the fact that plowing in itself does not kill many borers; as a control measure its only direct, mechanical value is its ability to handle trash in such a way that the larvae are driven out of the buried trash and can find on the surface no debris within twenty-five feet into which they can bore for further protection.

The seven hundred seventy-four 16-in. gangs and 18-in. sulky plows, which the government used in compulsory clean-up work last spring, functioned well in handling and covering trash where conditions for plowing were good. But we were forced to use some of these plows in heavy soils which ordinarily are not plowed in the spring; here, according to the special plow men who followed the outfits, only about 55 per cent of the plowing was acceptable from the standpoint of control. The plows had turned the trash under, but the soil came up in such a cloddy condition that the trash on the plow sole was boldly exposed by the fissures between the clods. Under such conditions the claim was made that the 16-in. bottoms handled the conditions a trifle better than the 18-in. bottoms.

It seems to be the consensus of those who followed operations closely last spring, and of those who have been in close touch with the experimental work this fall, that it is easier to cover trash with the wider bottoms. But some very pertinent questions are being asked about the relative pulverizing ability of the shapes of 14, 16 and 18-in. plows now found in the infested region.

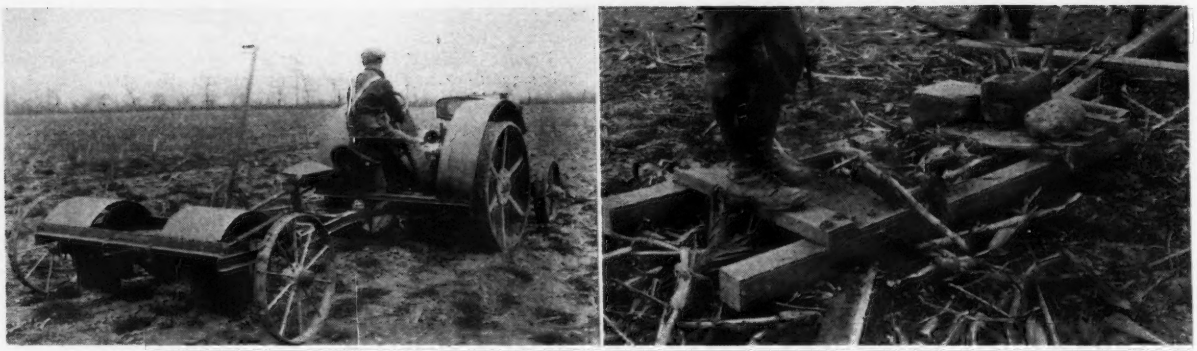
D. A. Isler, another member of the department of engineering and maintenance, is just completing a rather comprehensive study in which 12, 14, 16 and 18-in. bottoms have been used in different soils, under different conditions of trash, with various auxiliary covering devices, and with different previous surface treatment. Coverage counts are taken immediately after plowing, again after a heavy rain, and they will be taken a third time next spring. As the data are not complete and as a presentation of only part of them might be misleading, none of it will be given at this time other than to say that evidently the 12-in. plow simply cannot compete in plowing under whole stalks. In this same series of tests, Mr. Zirckel's trash shields are being used and are a real help. Results of this work will be made available as rapidly as possible and should be of value to manufacturers, colleges and farmers alike.

A large amount of investigational work and some development work on this subject of plows is in order, and it is hoped that the typical corn belt states will tackle the problem before the borer arrives there. Correlations between widths, depths and shapes; previous surface treatment; auxiliary covering devices; surface workers as attachments to plows; correlation between plow sizes and the farmer's power scheme; the previous treatment of the border strips of plowed fields—are all open subjects from the standpoint of corn borer control.

Burners. The use of the sixty-four big field burners owned by the government was confined entirely to the heavily infested counties along the Great Lakes. As heavy artillery and as emergency equipment they performed a remarkable service, though the wet season of last spring made the burning operations more costly than usual.

Burning, when properly done, is considered the surest shot we have. Farmers complained to some extent, claiming that the money spent in burning operations should have been used for a larger extra labor allowance. It is interesting to note, however, the marked decrease in infestation in some counties in which considerable burning was done. For instance, in Lucas County, Ohio, which is badly infested and where many acres were burned, the average infestation now is only about one-half that of 1926; yet the infestation over the entire area has increased. When asked recently what would have happened in Lucas County had there been no enforced clean-up, the county agent replied: "We would have had no corn."

There is something mysterious about the burning opera-



(Left) The stubble pulverizer—a special corn borer weapon. (Right) A farmer's homemade stalk shaver. It is used preparatory to raking and burning the stalks

tion and some basic research is needed. Besides studies to improve present burners, other researches are in progress at Toledo to determine more about conditions for burning, the requirements for heats and exposures, and the efficiency of different fuels. Whether or not small burners can be made successful and economical in operation for the use of individual farmers is an open question. A burning attachment for a Fordson tractor is about ready for testing at Toledo. This is called the Bowen machine, designed by the U.S.D.A. division of agricultural engineering. The general engineering department of Deere and Company has built a small burner for tractor use which seems very promising. This machine is being tested this fall.

The subject of burning should be studied and pushed. It may be of great importance to the heart of the corn belt within a comparatively short time. It would be amusing were it not pitiable to hear combustion experts tell how easy it is to solve the corn borer burning problem. Several have rushed in only to "get burned." Those who contemplate work of this kind will do well to study all that has gone before, and to get well in mind the peculiarities of the requirements and conditions.

Incinerators. Small, two-wheeled, portable incinerators were used in an experimental way with scavenger crews last spring. They consumed the stubble and stalk debris as rapidly as a half dozen men wanted to pick it up, but the grates, which were not cast iron, kept burning out. If hand picking must continue, there may be some opportunity for incinerators. In fact, they may be useful if field cleaners are perfected. Suggestions have been made concerning combination stalk loaders and incinerators, combination field cleaners and incinerators, and combination potato diggers and incinerators to raise and consume corn stubble.

Ensilage Cutters; Husker-Shredders. We have nothing new to report on the former. The engineering department at Toledo will do considerable work on husker-shredders this fall and winter to determine the effect of adjustments and the relative efficiency of cutter heads, shredder heads and combinations.

Feed Grinders. The subject of mealing stover is being investigated from the standpoints of animal husbandry, engineering and corn borer control.

Leakage. Before leaving the subject of equipment a warning must be sounded as to the dangers of leakage from present types of implements. By leakage we mean the portions of the corn plant which escape the machine or leak away from it during the machine process. Stubble, leaves, pieces of stalk, and husks, of shape and size to harbor living borers, are all leakage if they escape or leap from the corn binder, shaver, pulverizer, field ensilage harvester, rake, plow, picker or burner. At first thought this may not seem serious. But suppose, for instance, that three per cent of the bulk of the plant remains as stubble, five per cent leaks away from the binder, another five per cent is lost when the shocks are handled, and five per cent escapes treatment when the barnyard or feed lot is cleaned out. In the aggregate enough of the plant has escaped control to remain a very decided menace even though it is not highly infested. Entomologists are continually calling our attention to the dangers of leakage and agricultural engineers must strive for one hundred per cent treatment of all corn debris.

Along this line a very interesting piece of work has just been completed by Mr. Gray's and Dr. Caffrey's men in a very badly infested field in Canada. This field was handled by low-cutting corn binders, stubble pulverizers and field ensilage harvesters. The badly riddled condition of the stalks permitted excessive leakage and the results were far from being satisfactory from the standpoint of safe control. A complete description of this work, with all data, will be made public soon. It is mentioned here simply to emphasize the fact that if we permit the infestation to get very heavy, then some types of stalk handling equipment fail.

SOME SUGGESTIONS FOR THE FUTURE

As previously mentioned, one of the greatest needs today in the infested area is a mechanical device to clean fields properly before small grain is disked in, or a machine to pick up dangerous debris that remain on the surface after small grain has come up. Those of you who witnessed clean-up operations last spring were impressed with the pitiable plight of farmers, who, with their wives and children, hand-picked fields, two, three, and four times. Many of these farmers performed this operation without grumbling, because they had witnessed the borer's devastation. At the same time Indiana farmers, who had not yet been hurt, were leaving dirty fields and claiming that it was humanly impossible to get them cleaner. This simply shows the difference in attitude between the farmer who has suffered and the one who has not. It suggests the sad awakening to which the corn-belt must come.

Special field cleaners are not an easy task, but some experimental work to test out certain principles has been done and indicates real possibilities. A simple, wide-swath, one-horse trash picker is suggested for fields in which small grain is already above the surface. If rakes cannot be developed to clean fields properly, then some sort of surface cleaners are going to be necessary. These may be of the sweeper type, of the vacuum type, of the picker type, or may involve some principle not yet advanced. Of course, if all farmers burned fields, or if all farmers cut stalks with stalk handling machinery that succeeded in processing one hundred per cent of the plant, there would be no need for special cleaners. But those in the corn belt, where ninety per cent of the stalks are left in the field, should give this subject of cleaners some careful thought.

Inasmuch as it seems only fitting that the early development work on cleaners should be done by a development organization, the engineering department at Toledo plans to carry the subject further during the next few months.

Another badly needed implement is a two-row corn shocker equipped with low-cutting mechanism. Corn shocking, although an antiquated method to some of you, is a necessity in non-oats regions where wheat follows corn; otherwise the farmer must sow wheat between the corn rows. Cutting and shocking corn by hand is not only a laborious task but it also leaves a high stubble and dirty fields. Shocking after a corn binder is also a back-breaking job. But a corn shocker

will both cut and shock mechanically, and the two-row feature is strongly advocated to permit the operator to travel back and forth across a field of leaning corn without having to cut in lands.

The new Demorest, two-row corn shocker, as now proposed, seems to have real possibilities and manufacturers' attention is invited to it. Those of you who are familiar with Mr. Demorest's attempts in the past should not hold old prejudices against the new machine.

In addition to effort along the lines suggested above, grave thought must be given to ways and means of simplifying the whole problem. Continually we have to withdraw from the complexity of detail in order to see the whole picture again. What fundamental changes are taking place, or can be brought about, into which farmers can be led in order to simplify the problem? Of what influence are the developments in dehydration? If the grain combine means the loss of straw, will corn stalks be substituted in straw uses? What influence will the use of stalks for commercial purposes have, and how rapidly is this sure development going to be felt? These and many other big factors must be watched, sought out, predicted, studied, and prepared for.

In regard to future developments for the typical corn belt states, I hesitate to say much because there are undoubtedly, others who have some very interesting things to tell you regarding the use of machinery in handling crop refuse preparatory to commercial processing. The use of corn stalks in the manufacture of other products, however, is a double first cousin of corn borer control, and the federal control officials are just as much interested in present methods in the corn belt states as they are interested in the region already infested. They want to see all states prepared when the borer arrives.

It is very evident that the corn borer will reach Illinois and Iowa before all farmers sell their stalks annually. Hence, the heart of the corn belt is going to have to face in no small way some of the very problems that now face us in the infested region. In the corn-growing states in the center of the Mississippi Valley, however, the more standardized procedure of handling corn should simplify the problem a little. Aside from machinery to handle stalks for commercial uses, it now appears that the central states are going to be interested in stalk shavers, rakes, plows, small burners, special cleaners and combination machines which harvest the corn and destroy the borer in one trip over the field.

At a meeting called by Mr. Worthley and held in Chicago in June, 1926, a combination corn harvester was proposed, and data presented to indicate the economy of once-over methods in comparison to methods now in vogue to meet control. These data appear on page 168 in the 1926 A.S.A.E. Transactions; the machine was proposed to pick and husk the ears, cut the stalks close to the ground, shred the stalks, and spread the shredded material over the field, load it, or deposit it in piles or in windrows. It is well known that Deere and Company built such a machine and demonstrated it in 1926. That company carried on further experimental work this year and a report from the company would be interesting, if it feels that it can discuss this and similar matters at this time. Personally, I believe firmly that there is an opportunity for "combines" in corn harvest aside from the influence of the borer and of commercial use of stalks. But the latter factors will tend to force the issue—it is simply carrying to corn the principle that is creating such a furore in grain harvesting. If one doubts the combine idea, I wish that I were permitted to tell you of a machine discussed last summer with a large manufacturer, which not only has possibility for baling the stalks but also partially processes the grain corn.

Last spring the Peerless Malleable Iron Company, of Toledo, built a picker-husker-cutter type of combine which is worth inspecting. By shortening the path of both the ears and the stalks the machine is unique in its compactness—and it worked.

It is hoped that those working on combinations for corn harvesting will keep in mind the dangers of trash leakage already referred to, and take steps to conquer this difficulty at the start; otherwise the borer later may force a reworking of plans.

On behalf of the corn borer control authorities may I take this opportunity to express to the manufacturers the appreciation and thanks of all for the loyal manner in which commercial interests have supported the corn borer fight and for the patience they have shown through the trying problems put before them.

The engineering department at Toledo has in rough draft a classification and list of mechanical problems in corn borer control. This lists one hundred and forty-one problems for study. If there is a demand for this list, the presentation can be reorganized and reproduced for distribution. That department stands ready to assist wherever it can and seeks the cooperation of all for progress in the common problem.

Discussion

Preceding the presentation of the foregoing paper, the author, Mr. Reed, called attention to the presence of L. H. Worthley, head of the Federal Administration for Corn Borer Control, who was invited to speak forthwith. In the course of his very brief and informal remarks Mr. Worthley said:

"The principal thing I can tell you is that we need every one of the engineers in this problem of corn borer control. While I am on the entomologist side of it, I have great belief in what the engineers are doing to help us solve this problem. That may not be done this year or next year, but I believe by the time the corn borer has infested the corn belt proper that the engineers will have something for the farmer whereby he can do his work as economically, if not more so, than he is doing it now, and still take care of the corn borer in a good, fair way."

In introducing his remarks Prof. Reed exhibited maps and quoted data showing that quarantine and other control measures had limited the spread of the borer to the uncontrollable minimum of flight by the moths themselves, with the exception of one isolated point similar to the one discovered near Kankakee the preceding year, which infestation was stamped out in a way that it is hoped can be duplicated with the new infestation this year. He showed how the actual total number of borers was not reduced, but that the normal and previously prevailing rate of increase had been very substantially reduced, and this in spite of the fact that of the three basic stipulations originally laid down by the control engineers only one was complied with. The funds were not available until 45 days beyond the limit set, and the spring was probably the wettest in the region for many years, making conditions highly favorable for the advancement of the insect.

Following Mr. Reed's paper, President O. B. Zimmerman commented on the fact that in addition to the handicap of delay and extremely unfavorable weather the corn borer workers had to proceed in spite of a certain amount of guerilla warfare in the form of demagogic politics, unfavorable newspaper comment, and legal obstacles attempted by unbelieving farmers. He also found encouragement in the presumed fact, indicated by observation though not yet proven by statistics, that corn production along the best lines for borer control and employing the best equipment and methods the engineers have devised not only is satisfactorily effective in borer control, but sufficiently more productive to repay all the extra cost of that control. He added a warning that engineers must be alert as there is likely to be a marked upset in the methods of handling the corn areas before we are through with the borer problem.

President Zimmerman also proposed, and there was adopted, a resolution to "commend highly the success of the work done by the U. S. Department of Agriculture and officers and men serving on this problem," and asking for widespread publicity "in order that the agriculturists in the corn belt and the country in general may be so informed and give their further support to its continuance until still more complete control is obtained." Before adoption, however, the resolution was amended to include the part played by the states.

Continuing the discussion E. W. Lehmann, of the University of Illinois, mentioned that some of the colleges, including his own, were handicapped in studying and attacking the borer problem by reason of inadequate research funds. Mr.

Lehmann believes that some of the primitive expedients and cheap implements which serve well enough in the more eastern areas will be entirely inadequate when the corn borer reaches the corn belt. He advanced the idea that stubble pulverizing will not be a solution, because there should not be much stubble to pulverize, both because of difference in handling the corn crop and also because of the growing belief that the stalks should be and will be harvested for commercial purposes.

In this connection Mr. Lehmann mentioned that a company at Danville, Illinois, has purchased several thousand acres of corn stalks for use in pulp production, and these people want the stalks to be baled. There appears to be a need for a machine that will harvest the corn, either by snapping or husking, cut the stalks and bale them in one operation without getting the stalks dirty—an important point. Also, as developed by others, it is highly important that the stalks be cut very close to the ground and that no fragments of the corn plant be left in the field.

In line with the growing evidence that a satisfactory degree of borer control is possible by plowing methods, Mr. Lehmann emphasized the difficulty in getting men to do really good plowing, mentioning troubles he had encountered in this respect on the experiment station farm and another instance in which a farmer had been assisted to accomplish a complete job of covering, but the next day he was found to have taken off the covering wires and was continuing his plowing in the same old slovenly way. Notwithstanding the seeming absurdity of teaching plowing to a farmer who has been doing it for forty years, it seems that there must be nothing less than a comprehensive and forceful educational campaign to teach farmers how to plow.

Theo. Brown, of the John Deere Plow Company, being called upon, reported that the corn combine, a part of the problem assumed by his company for study and development, has been completely rebuilt several times in the latter of the two years in which work has been done on it. The principal difficulty seems to be with leakage of corn plant fragments, a very serious matter. He told also of a stalk burner which had been designed for operation with an ordinary tractor as a one-man outfit. Beginning with a killing efficiency of 88 per cent, a short period of experimentation in the field reached a point of 96 per cent efficiency, with at least a hope of reaching a practical efficiency close to 100 per cent.

H. W. Riley, of the New York State College of Agriculture at Cornell University, mentioned that in his state, which is just about 100 per cent infested, the farmers have been prompt and even enthusiastic in adopting the low-cut harvester, but are much more reluctant about improving their plowing methods. One approach to the problem was by promoting plowing contests in connection with fairs, the initial effort being long on interest but short on entries. However, it is hoped to expand this work along the lines of a sporting proposition and eventually to have a state competition.

Another contributor to the discussion, speaking from the standpoint of the territory as yet uninfested, stated that their farmers were rather inclined to regard the corn borer and its control as a little bit of a myth, but that by advocating better plowing simply as better farming, the response was much better.

The final phase of the discussion had to do with the fertility value of corn stalks as affecting corn borer control methods. The question being referred to Mr. Reed he stated that the soil men were divided on this point, some holding that the presence of stalks in the soil was actually detrimental, not from the tillage viewpoint but from that of fertility, while other soil authorities assert that the stalks have a fertility value of something like $5 an acre. He ventured the guess that the weight of opinion was with those who believe the stalks to have a substantial fertility value, and in consequence borer control by plowing under would be rather largely preferred.

But this, in turn, opens up additional questions not only as to the completeness of trash covering which is necessary, but also the depth to which the stalks should be buried. Instances were cited of fields which apparently were very well plowed and passed inspection, but after a hard rain the soil was washed and beaten down to such an extent that the protruding pieces of stalks would have failed to stand inspection. Some definite agreement or expression from the soil men as to whether corn stalks have a fertility value should be made before the engineers can attack their part of the problem with assurance that they are on the right track.

A Homemade Lime Spreader

By J. C. Wooley[1]

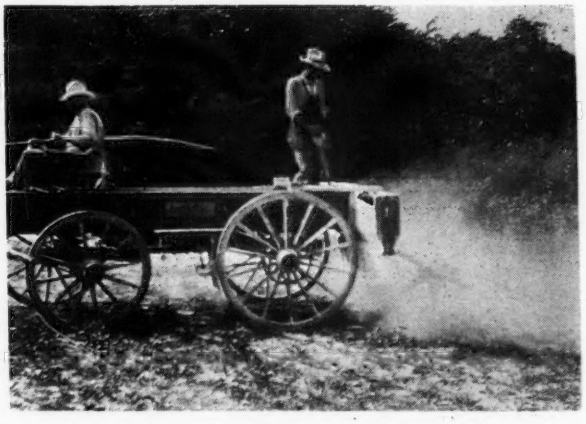
IN ORDER to introduce the use of limestone on some of the sour soils of Missouri, it was found necessary to have some kind of a cheap homemade device with which to spread the lime. The man who was skeptical about the use of lime could not be induced to make much of an investment in equipment. A spreader was built and tested out. Two objections were found to this machine and experiments were started in an effort to eliminate them. First, the spreader could not be changed from one wagon to another unless the hubs were standard. Second, the shaker bar was pulled back so quickly by the spring that most of the lime was delivered on one side of the bar and resulted in uneven spreading.

The machine shown in the accompanying illustration is self-contained and needs only to be fastened to a wagon box for use. The removal of two wing nuts is all that is necessary to remove the machine from the wagon. If the fields are in condition where the lime is being hauled, the spreader can be set in place and the lime spread direct. Having a spreader that will fit any wagon high or low is an advantage under these conditions.

The drivewheel is arranged to push the shaker bar ahead from center three-fourths inch and to pull it back from center an equal amount. This causes the lime to be distributed from both sides of the shaker bar and results in more even spreading.

This machine will not handle wet lime satisfactorily, and thus does not meet the needs in this case.

Over one thousand plans have been sent to thirty-seven states since September 1, 1926, and through correspondence and contacts we have made with owners near Columbia, we find that the spreader is serving in the program of greater use of lime in Missouri.



The Missouri homemade lime spreader in action

[1]Professor of Agricultural Engineering, University of Missouri. Mem. A.S.A.E.

The Effect of Some Seed Treatments on the Wear and Accuracy of Drop of the Corn Planter

By B. Koehler[1] and R. I. Shawl[2]

CHEMICAL dusts for the treatment of seed corn to prevent certain seedling diseases have recently been widely advertised and recommended in the United States by two manufacturers of these materials. Some results published by federal and state agricultural investigators also seem to indicate that at least under some conditions such treatments may be beneficial to the resulting corn crop. It is known (The Extension Pathologist, U. S. Department of Agriculture, June, 1927) that the copper carbonate dust treatment on wheat shortens the life of the wheat drill, but nothing was known about how dust-treated corn affects the corn planter. Therefore, the authors tried to determine: (1) How these dust treatments affect the life of the planter and (2) how the treatments affect the accuracy of drop.

The two dusts used were: "Bayer Dust," manufactured by the Bayer Company, Inc., New York City, and "Semesan Jr.," manufactured by E. I. du Pont de Nemours and Company, Wilmington, Del. The samples were received from the manufacturers early in the spring of 1927. There were no numbers on the packages by which the formula used at the time could be identified, only the trade name being given.

Carefully graded sound yellow dent corn was used. The dust treatments were used at the rate of two ounces per bushel. A thorough mixture was obtained by the use of a treating machine made from a barrel as recommended by the U. S. Department of Agriculture and a number of state agricultural experiment stations for the dust treatment of wheat. This dust-treating machine is shown at the right in Fig. 1. The corn was run through the planter a maximum of ten times, both treated and untreated being run through the same number of times. Each time after being run through twice, the treated grain was given an additional treatment of one-half ounce per bushel to make up for loss.

The corn planter available for this experiment was a Deere and Mansur, No. 999. It was set up on a raised platform and operated from a lineshaft as shown in Fig. 1. The trip was arranged to drop once with every revolution of the planter wheel. A magnetic c unting machine was attached to count the number of hills dropped. The corn was dropped on moving belts so that counts could be made on the accuracy of drop. The planter was set to drop at the rate of three kernels per hill. At the end of each belt the corn was dropped into a tub.

Treated corn was run through one side of the planter and a non-treated check was run simultaneously through the other side. The corn was kept at the same level in both planter boxes by an automatic feed as shown in Fig. 1. It was realized that there might be a difference in the accuracy of drop of the two sides or a difference in the wear of the two plates, regardless of the seed treatment used. To guard against a systematic error of this kind, two trials were made. Hills equivalent to planting 100 acres (3556 hills per acre) were put through each side of the corn planter for each trial. After the first trial was completed, the machine was thoroughly cleaned, the plates were weighed, and then the second trial was run by reversing the seed so that the treated seed passed through the planter on the side where the non-treated seed had passed in the first trial. In the different trials a total equivalent of 800 acres was planted, or perhaps as much as an average corn belt farmer would plant in ten years.

Seed plates best adapted to the size of corn were selected, and a new pair of plates was used at the beginning of the experiment with each dust.

To determine the effect of these dust treatments on the life of the planter, only the seed plates were taken in consideration. Wear on other parts to which the dust has access would probably be somewhat in proportion. The seed plate rests on the stationary plate holder beneath it and the two surfaces rub together when the seed plate is in motion. Furthermore, there is a device above the seed plate called the cutoff knocker which bears down on the plate by means of a spring. All these parts are made of a hard grade of cast iron. The question is whether these parts wear more when the iron surfaces are mostly in direct contact, as when non-treated corn is used, or whether the chemical dusts of treated corn which lodge between these parts cause the greater wear.

The results obtained are given in Table I. It will be noticed that the dust treatments caused a reduction in wear. Evidently these dusts act somewhat as a lubricant. This was especially evident in the case of Bayer Dust where the reduction in wear was 31.6 per cent. It was concluded, furthermore, that the wear on the seed plates with or without treatments on the seed probably are not one of the limiting factors in the life of the corn planter. A seed plate could likely lose five per cent of its weight by natural wear before it would seriously affect the accuracy of the machine's operation. It is estimated that under the conditions of this test

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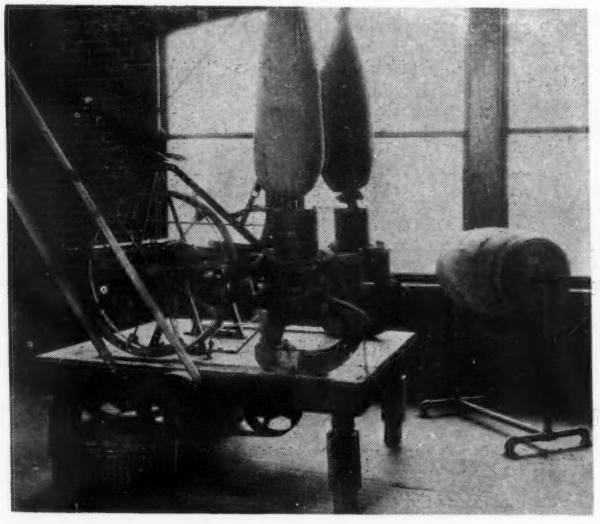


Fig. 1. The Deere corn planter set up for the experiment to determine the effect of seed treatments on the wear and accuracy of drop

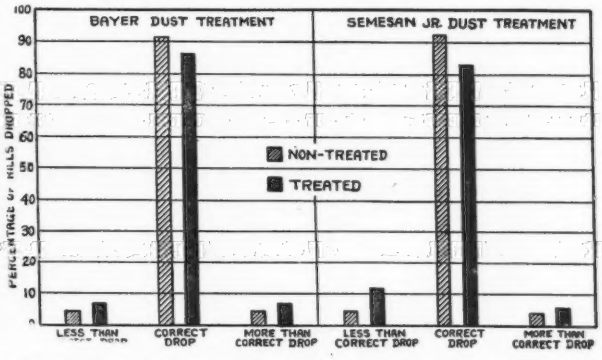


Fig. 2. Graphic presentation of the relation of dust-treated seed corn to accuracy of drop as compared with non-treated corn

TABLE I. Loss in Weight of Seed Plates that Occurred while Planting 100 Acres of Corn

Seed treatment	Trial I	Trial II	Average	Reduction in wear when treated seed was used	
	grams	grams	grams	grams	per cent
None	0.480	0.425	0.453		
Bayer Dust	0.305	0.315	0.310	0.143	31.6
None	0.485	0.450	0.468		
Semesan Jr.	0.400	0.345	0.373	0.095	20.3

TABLE II. Accuracy of Drop of Treated and Untreated Seed

Seed treatment	Trial I	Trial II	Average	Reduction in accuracy of drop when treated seed was used	
	per cent	per cent	per cent	difference	per cent
None	91.3 ±0.8	91.1 ±0.7	91.2 ±0.7		
Bayer Dust	86.5 ±0.4	85.8 ±0.7	86.2 ±0.7	5.0 ± 1.0	5.5
None	91.9 ±1.1	91.5 ±0.5	91.7 ±0.9		
Semesan Jr.	85.3 ±1.1	80.2 ±2.6	82.8 ±2.6	8.9 ± 2.8	9.7

TABLE III. Weight of Corn that Passed Through Corn Planter in Planting 100 Acres

Seed treatment	Trial I	Trial II	Average	Reduction in amount when treated seed was used	
	lb.	lb.	lb.	lb.	per cent
None	807.5	805.7	806.6		
Bayer Dust[3]	809.9	805.1	807.5		
Bayer Dust[4]	808.3	803.5	805.9	0.7	0.09
None	808.2	811.8	810.0		
Semesan Jr.[3]	798.6	793.4	796.0		
Semesan Jr.[4]	797.0	791.8	794.4	15.6	1.93

[3]Weight of dusted grain.
[4]Correction made for weight of dust.

10,000 acres could be planted before that much were lost. Of course, if the plates were allowed to become rusty one would expect them to wear down faster.

A more vital and unfavorable effect was revealed when the accuracy of drop was determined. Counts were made simultaneously on the drop of the treated and untreated corn. These counts were repeated at intervals until a total of 6000 hills had been observed in each trial of 100 acres. The results are given in Table II and shown graphically in Fig. 2. Both dusts decreased the percentage of accurate drop as compared with the non-treated checks. This reduction in accuracy was 5.5 per cent with Bayer Dust and 9.7 per cent with Semesan Jr. As shown in Fig. 2, in the checks the inaccurate drops were nearly equally distributed below and above the correct number. With Bayer Dust treated seed this was true also but the percentage of inaccurate drop on each side was a little higher than in the case of the check corn. In the case of Semesan Jr. treatments the inaccuracy predominated on the minus side. This included even some missing hills.

The amount of corn that was run through the corn planter on the treated and non-treated sides was also weighed. The summary is given in Table III. In order to make a more accurate comparison, a correction was made for the weight of dust on the dusted grain. As the dust was applied at the rate of two ounces per bushel which is 0.223 per cent, and allowing for some loss in the planting operation, a correction of 0.2 per cent was made. In the Bayer Dust test it was found that the weight of corn that passed through the planter, treated and non-treated, was practically the same. With Semesan Jr., there was a reduction of nearly two per cent on the treated side. This corresponds very closely to what one would expect from the result shown in Fig. 2.

While handling the treated corn, it appeared that it flowed less freely than the normal untreated corn. This was especially noticeable with the Semesan Jr., treatments. Although these dusts acted as a lubricant between the cast iron surfaces, the untreated corn kernels naturally are very smooth and here the dusts seemed to retard the sliding action. This seems to be one cause for the greater inaccuracy of drop with treated seed, but possibly there may also be other causes. Keeping in mind the importance of the ease of flow of corn in the planter box, these dusts can perhaps be modified so as to overcome somewhat this inaccuracy of drop.

SUMMARY

The dust treatments of seed corn used in the experiments here described apparently do not aggravate the natural wear of the planting mechanism of the corn planter but rather have a lubricating effect on these parts. These same dust treatments, however, were found to decrease the accuracy of drop. There was a difference in this respect in the two treatments used. This fault can perhaps be largely overcome when the manufacturers of dust treatments take the efficiency of machine planting into consideration.

A Unique Plan to Give Farms Electricity

WHILE the question of rates for farmers is being discussed by power companies throughout the country, one of the New England companies, the Hartford Electric Light Company, of Hartford, Conn., have announced a plan which is rather unusual in its make-up and which may have a profound effect on rural electrification throughout this country. In its announcement the company states the two major problems to be solved before farmers can be furnished with electric power at attractive prices are as follows:

1. Find out how enough power (assuming an attractive price) can economically be used to make rural lines self-supporting.

2. Find a method of financing the relatively large investment in power machinery which is essential.

The success of the plan developed by the company will depend upon the farmers taking sufficiently large quantities of power to make the experiment a success.

The rates established for current to farmers include a demand charge (2 kw. minimum) of $3.50 per kilowatt per month. This charge the company will waive for a period of five years to the extent that the customer is purchasing apparatus to be electrically operated. Then there will be an energy charge (minimum, 80 kw.-hr. per month per kilowatt of demand) of 2 cents per kilowatt-hour.

At the expiration of a five-year period the customer will have the option of electing in place of the "farm rate" any applicable rate available to other customers of the company. Furthermore, the agreement may be cancelled by the customer after one year by giving the company 30 days' written notice.

The cost of line extensions will be assumed by the customer, minus the following credits: (1) Total amount of energy charge paid to the company over a period of three years from completion (including payments made by others taking service from the extension), and (2) $100 for each kilowatt of use developed at the end of three years. By this arrangement, if current is used liberally on a farm, the cost of the line extension may be reduced to a very small figure.

To go one step further, the company will finance the cost of line extensions on notes of the consumer, although the esponsibility for the cost of the line must be assumed by the customer. This last provision makes it possible for a farmer to have a line extended to his premises without making it necessary for him to raise the cash in advance.

Big Savings in Ditch Blasting

A DEMONSTRATION in the use of explosives for blasting ditches near Durand, Michigan, developed some interesting data. An old ditch filled in about two feet at the bottom was the one used in the demonstration. Estimates secured by local authorities had placed the cost of clearing it at $10 a rod, while the best bid obtained was at $12 a rod. Figures on the demonstration show that the materials required for blasting this cost $2.36 a rod while labor cost 50 cents, a total cost of $2.86 a rod for the work. Three rows of holes 18 in. apart, with the rows 40 in. apart, were used. One stick of 50 per cent straight nitroglycerine dynamite was placed in each hole. The blast cleared a good 12-ft. strip at the bottom of the ditch.

The blasting of ditches with dynamite is coming into use more and more extensively. On the opposite page is an article dealing with ditch blasting studies in Missouri.

Some Results of Adapting Explosives to Ditch Blasting Requirements

A. J. McAdams[1]

ABOUT ten years ago when dynamite was first used to blast a ditch at Diehlstadt in southeast Missouri, it was readily apparent that explosives had possibilities of being an effective factor in drainage work. Since then dynamite has been used with more or less success, but the resulting ditches have left the impression that some vitally important phases of the work were not thoroughly understood. The fact that the explosives have become an established agent in drainage work, and the varying results under varying conditions, led to definite investigational work under practical conditions.

It was very evident from the work in Missouri that, if dynamite for ditching was to be a satisfactory, economical agent, more definite information based on actual field investigation was essential. The rapidly increasing demand for explosives for ditching and the many problems confronting this activity further stimulated the need for practical, definite information on this subject.

It should be stated at this point that, when ditching with explosives is mentioned in this paper, the propagation or transmission method of blasting is meant. In order to carry on ditch blasting with this method, it is vitally essential that a straight nitroglycerin dynamite be used in soil that is wet or very damp.

The first problem had to do with the practicability and the suitability of the explosive itself. This was divided into three sections: (1) The advisability of using a 60 per cent or a 50 per cent straight nitroglycerin dynamite for ditch blasting, (2) the requirements which a satisfactory ditching dynamite should meet, and (3) the possibility of using a smaller cartridge than the regulation 1¼-by-8-in. cartridge for ditch blasting.

[1]Extension agricultural engineer, University of Missouri Assoc. Mem. A.S.A.E.

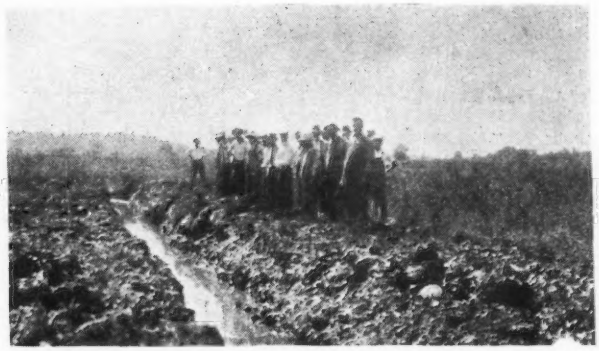
(Top) A ditch that was blasted through brush, stumps, and logs in January, 1926, at an air temperature of 40 deg. F., on the Leo Schott farm, near Oran, Mo. (Below) This picture shows a crop on the same field the following summer. The ditch may be noted in the center of the picture

Precedent had convinced a large majority that 60 per cent straight nitroglycerin dynamite was best adapted to ditching work, and practically every one doing ditch blasting in Missouri was using this strength dynamite. In order to economize further on ditch blasting and at the same time secure the desired results, it was decided to introduce 50 per cent straight nitroglycerin dynamite. After a series of test blasts, not only in southeast Missouri but through the central and northwest sections of the state, using the 50 and 60 per cent straight nitroglycerin dynamite in the same ditch, it was proven conclusively that 50 per cent straight nitroglycerin dynamite would give the same results as the 60 per cent dynamite under similar conditions and at a lower cost. Possibly there are a few places where the 60 per cent dynamite is more desirable, but it is felt that these conditions are widely scattered and for this reason only the 50 per cent straight nitroglycerin dynamite is being recommended for ditching work with the propagation method.

The next important step concerned the requirements which a satisfactory 50 per cent straight nitroglycerin dynamite should meet. It had been noted in several instances, where conditions were apparently suitable for propagation, that the explosive failed to propagate or was erratic in action. Moisture conditions in the soil and soil temperatures were satisfactory, and it was logical to believe that the dynamite was largely at fault. Upon weighing the cartridges from several cases of 50 per cent dynamite, it was found the weights varied from ½ to 1½ oz. per cartridge. Case counts of this dynamite showed a range of 98 to 110 cartridges per case. The erratic action of the dynamite under conditions suitable for propagation could not be readily explained. Cartridges varying in weight also varied in density, and also in sensitiveness in the soil.

To prove these conclusions several cartridges having the same weight were placed in the ground, and the resulting blast produced a more uniform excavation, and propagation was complete. From these blasts it was found that case counts of one hundred 1¼-by-8-in. cartridges, plus or minus three per 50-lb. case, would meet the requirements of uniformity or density and sensitiveness and give satisfactory execution. These determinations prove beyond any question of doubt that uniformity on the stick basis with regard to density, and therefore sensitiveness, is the first and foremost requirement of a satisfactory nitroglycerin dynamite for propagated ditch blasting.

Another requirement which a satisfactory explosive for



A section of ditch blasted with 50 per cent and 60 per cent straight nitroglycerine dynamite. This group of farmers could see no difference in the resulting ditch

Cost Data and Other Information on Ditching with Explosives as Supplied by Landowners

NAME	Depth to top of last cartridge—in.	Distance apart—in.	Air temperature—deg. F.	Soil temperature—deg. F.	Soil condition	No. of cartridges per hole	Average width—ft.	Average depth—ft.	Length—ft.	Pounds dynamite used	Dynamite per cent	Cubic yards blasted	Number man-hours	Cubic yards per pound explosive	Cubic yards per man-hour	Explosive cost per cu. yd.—cents	Labor cost per cu. yd.—cents	Total explosive cost	Total labor cost
Givens	12	16	44	43	Medium wet	1	5	3	594	200	50	330	12	1.65	27.5	14.5	1.3	$ 47.78	$ 4.50
Ernest	8	16	58	60	Wet	1	4	3	305	300	50	355	24	1.2	27.9	15.9	1.7	56.75	6.00
Ladd	12	18	59	61	Wet	1	4	3	3300	1300	60	1467	100	1.13	14.6	20.8	2.7	305.75	40.00
Cunningham	12	16	50	52	Wet	1	3½	3	2310	800	60	898	120	1.12	7.4	17.8	3.3	161.22	30.00
Matthews	20	14	60	63	Very wet	1	4	4½	5478	2100	60	3652	200	1.74	18.2	11.8	1.8	424.00	66.40
Creech*	6	14	36	34	Very wet	1	4	3	1980	570	50	880	30	1.54	29.3	14.5	1.0	127.02	9.00
McRoberts*	8	16	38	36	Very wet	1	5	3	2685	1000	50	1491	64	1.49	23.3	13.4	1.5	200.17	22.50
Schoff*	6	16	38	37	Very wet	1	5	3	1080	400	50	664	48	1.64	13.9	13.1	1.9	87.00	12.00
Byrd*	8	16	40	38	Wet	1	5	3	1980	1000	50	1320	96	1.32	13.8	15.5	1.8	205.00	24.00

NOTE: Ditches at Barnard and Rosendale, in Nodaway County, were given up because dynamite froze at 42 deg. F. Another at Malta Bend, the dynamite froze at 38 deg. as was evidenced by burning and failure of propagation. The same was true at Norborne at 42 deg. This led to investigations and the ditches marked with an asterisk (*) were blasted when ice was on the ground and sleet falling. At temperatures as low as 36 deg. no difference was noted.

ditch blasting should meet is sensitiveness in the soil when soil and air temperatures are at about 38 to 40 deg. F. This especially applied to Missouri for the reason that practically all of the ditch blasting is carried on during the winter or early spring months when demands from field crops are not so heavy. Previously nitroglycerin dynamite has been erratic in action during cool or cold weather, due to the freezing properties of the nitroglycerin which desensitizes the explosive. If the insistent demands of farmers and others for ditch blasting were to be met, it was very necessary to develop an explosive which could be used for propagated ditch blasting when soil and air temperatures were at 38 to 40 deg. Therefore, an explosive was developed which was entirely effective at the above temperatures with regard to safety, sensitiveness, execution and uniformity. Previously, it was necessary to place single cartridges 10 to 12 in. apart when the ground and air were cold, with no assurance of complete propagation. At the present time it is possible to space single 1¼-by-8-in. cartridges 16 to 20 in. apart, depending upon the soil moisture content and secure very satisfactory results, even when soil and moisture temperatures are at 38 to 40 deg. F. Under some conditions it is possible to space at even greater distance and secure propagation, but it is felt that by so doing the blaster is less apt to obtain a uniform excavation.

The third problem regarding the dynamite had to do with the possibility of using a cartridge of smaller diameter than the regular 1¼-by-8-in. cartridge which has been the standard for agricultural blasting. In this work three different size cartridges of 50 per cent straight nitroglycerin dynamite were used, 1¼-by-8 and 1⅛-by-8-in. These three sizes were used in the same ditch where conditions were suitable for propagation and soil conditions uniform. The resulting blasts indicated beyond any question that cartridges of smaller diameter were not economical nor satisfactory from the standpoint of results. A section of ditch 159 ft. long was blasted with a 50-lb. case of 1-by-8-in. cartridges containing 158 cartridges. This ditch averaged 2.3 ft. deep and 3.5 ft. wide. This section of ditch contained 47.4 cu. yd. The dynamite cost $23.25 per 100 lb. which made a cubic yardage cost of 24.5 cents. These charges were spaced 12 in. apart and 8 in. deep to the top of the cartridge. Another section of ditch 162 ft. long was blasted with a 50-lb. case of 1⅛-by-8-in. cartridges containing 124 cartridges. This ditch averaged 3.5 ft. wide and 2.6 ft. deep and was 162 ft. long and contained 54.7 cu. yd., or a cubic yardage cost of 21.3 cents. These charges were spaced about 16 in. apart and 8 in. deep to the top of the cartridge. The third section was blasted with 100 lb. of 1¼-by-8-in. cartridges, or 206 cartridges. The charges were spaced 16 in. apart and 8 in. deep to the top of the cartridge. The resulting ditch was 280 ft. long, 4.1 ft. average width and 2.7 ft. deep, or 118.5 cu. yd. at a cost of 19.7 cents per cubic yard.

The resulting blasts showed a very noticeable difference in the spread of the dirt. With the smaller size cartridge, the pieces of dirt were not as well broken nor were they scattered as widely over the adjoining field. The banks of the ditch where the smaller cartridges were used was more nearly vertical and were badly cracked and broken, while with the standard 1¼-by-8-in. cartridge the sides were more sloping and the banks fairly solid. With the 1-by-8-in. cartridge, the labor per rod was increased considerably due to the fact that the charges were spaced 12 in. apart, while with the 1¼-by-8 and 1⅛-by-8-in. cartridges the charges were from 16 to 18 in. apart. Propagation was complete with these two sizes and with the small size propagation was erratic and uncertain.

Following this work, two other trials were made with the same three sizes of cartridges in different soil types, and in each case the size of the ditch decreased with the smaller diameter cartridge. Likewise the labor cost increased while the size of the ditch decreased with smaller diameter cartridges.

From these trials, it is felt that the smaller diameter cartridges, 1-by-8 and 1⅛-by-8-in., do not have sufficient place in agricultural ditch blasting to be of any consequence. There are perhaps a few conditions where the smaller cartridges could be used, but these conditions are few and widely scattered. In the past the 1¼-by-8-in. cartridge has met every requirement from the practical standpoint, and it is very doubtful if smaller cartridges will prove economical and practical.

Push Binder for Rice Harvest

AN IMPORTANT development in rice harvesting machinery is the push binder which has been introduced during the past season. This binder, as may be inferred from the name, is pushed instead of pulled by the tractor. As with other modern traetor binders, it is operated by a power take-off from the tractor, a device which has greatly speeded up the rice harvest, as it was very hard to secure sufficient traction on the wet fields to operate wheel driven machines.

The immediate reason for the development of the push binder was an effort to discover a means of opening up the rice "checks," on fields, without tramping down a considerable amount of the valuable grain by the feet of horses or the wheels of tractors. While grain thus tramped down can usually be recovered when cutting the back swath of wheat, oats, and other small grain, rice does not rise sufficiently after it is tramped down to be caught by the binder cutter bar on the back swath.

Many rice growers who are using the push binder also pull a second binder behind the tractor.

Rice production is probably the most thoroughly mechanized of American crops, due to the large amount of power required. Nevertheless, the American rice grower, with labor at $4 to $6 a day with his tractors and other labor-saving machinery is able to produce rice at a cost so low that he can profitably sell it in oriental countries where coolies labor for 15 to 30 cents per day, as well as placing it on American tables at a very low cost.

Judging from studies made the past year, particularly by the rice investigations division of the U.S.D.A. Bureau of Agricultural Economics, it appears that the "combine" may eventually largely supplant other means of harvesting rice.

The Stationary Spray Plant*

By Harry L. Garver[1]

THE stationary spray plant is just what its name implies. As opposed to the portable rig with its pump, motor and agitator tank complete, mounted on a truck, the stationary plant is a fixed unit located at some convenient place in or near the orchard. The outfit as we find it being used in Washington orchards consists of a high pressure pump (three or four-cylinder) driven by any one of a variety of power units. A tank ranging in size from 600 to 1200 gallons capacity in which is located an agitator, is used instead of the 200-gallon tank of the portable outfit. The orchard is piped for carrying the spray material to the trees.

Not much has been written on this method of spraying. The earliest article I have been able to find was that of A. J. Dear's plant[2] and of Mr. Reed in the California Department of Agriculture's monthly bulletin for May, 1918.

The following studies were decided upon by the Washington Committee on the Relation of Electricity to Agriculture and as many of them made as were convenient in the field; others will be made at the State College of Washington later where conditions are more nearly under the control of the investigator:

1. Types of pumps
2. Kinds and amount of power
3. Mechanics of connecting power to the pump, i.e., by sprockets, gears, silent chains, pulleys, etc.
4. Measuring capacity of pump
5. Pipe losses—anything varying from a smooth piece of pipe, such as valves, L's, T's, etc.
6. Influence of pressure on atomizing of the spray
7. Types of nozzles and high pressures
8. Height to which spray will carry under different degrees of atomizing
9. How completely trees and fruit are covered at different degrees of atomizing
10. Efficiency tests on plants including pipe line, power transmission equipment and other parts
11. Installation and maintenance costs
12. Filtered water vs. ditch water
13. Distribution of faucets and length of hose

There were five types of pumps used, namely, Bean, Hardie, Myers, Friend and Ward-Love. The power used to drive these pumps involved almost every conceivable kind of gas engine and a variety of electric motors. The gas engines consisted of tractors; Ford, Maxwell and other automobile engines in various states of repair; and single-cylinder farm engines. Of the electric motors there were half a dozen different makes and sizes ranging from 3 to 15 horsepower.

Only a few single-cylinder engines were noted on the stationary outfits but a considerable percentage of plants were run with Ford engines. Many of these engines were taken out of old cars and connected to the pump, usually by means of roller chains and sprockets. Some of the new plants are being equipped with new four-cylinder engines. The dilapidated engines are being rapidly replaced by electric motors as the power lines are being extended and the old pumps replaced by new ones.

Very little definite information was obtained on the fuel consumption. Most of the farmers are normal and keep their records only by memory. The lowest fuel consumption found was 688 gallons spray material applied to one gallon of gasoline. The highest was 300 gallons of spray material to one gallon of gasoline. These were both Ford engines; one was a new engine when attached to the pump three years ago and the other was an old engine taken from an old Ford car recently. The best one has been used only for spraying. Two men each using tractors report one gallon gasoline to 400 gallons of spray material.

The electric-driven outfits were more easily checked, both on the job and by records obtained from the electric power company. The following record is from the Puget Sound Power & Light Company's Wenatchee district office for 1925;

Acres under stationary spray	1278.25
Kilowatt-hours consumed	60,623
Total revenue	$3,762.15
Connecting and disconnecting	$339.50

The following data gives the number of motors, acreages, etc.:

Size of motor horsepower	No. in Service	Acres	Horsepower per acre	Ave. revenue per acre
1½	1	4.00	0.375	$2.590
2	3	14.00	0.428	2.930
3	19	183.75	0.310	2.710
5	58	708.00	0.409	2.930
7½	14	298.50	0.352	3.047
10	2	70.00	0.286	3.234
479.5	97	1,278.25	0.376	$2.943

Average cost per acre per season (revenue only)	$2.943
Number of sprays	726
Average number of sprays per season	7.35
Average cost per spray	$5.18
Average cost per acre per season	$3.13

It must be remembered that this report refers only to the places on which electric-driven spray plants are located. The percentage of plants which were electric-driven was probably not over 30 in 1925. This figure is changing, however, as will be noted by the sales of new plants. The number of new plants sold in Wenatchee alone this year (1926) up to April 27 is about as follows: Stationary, 324; portable, 18; electric-driven, 270.

There are about 2500 fruit growers in the Wenatchee district, and it is estimated by the county agent that one thousand will be using stationary outfits by the end of this season. Several old portable rigs were cut down for stationary outfits but no statistics were available on these.

Not only direct-connected outfits were found. These should be best but the speed of the pump shaft is much slower than that of most power units. Of the geared outfits a large percentage were noisy. This is the least expensive method of connecting. The belt was used only where a tractor was employed to furnish power. Many farmers used the roller chain and sprockets with considerable satisfaction. The silent chain is used quite extensively, especially with the electric motor, and is proving to be one of the best means of power transmission. It is efficient, quiet, and with reasonable care will last for many years. The silent chain is probably the most expensive, but that has not been a serious drawback in the Wenatchee district.

During our first trip to the Wenatchee district for the purpose of studying stationary spray plants, we visited fifty-two outfits. The pipes on twenty-six of these farms were underground, or preparations were being made for their being buried. Twelve were on the surface and the remainder were overhead. No special trouble seemed to be experienced with any one type of system, except freezing or bursting under pressure. Freezing can be avoided by being careful to lay the pipes so they will drain well. Most breaks in pipes due to pressure occur in new systems, but may occur in any system.

In many instances the motor used was too small to carry the load successfully. Five-horsepower motors were found carrying a continuous load of almost eight horsepower. They ran hot of course. The power company was blamed for low

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*Paper presented at the 20th annual meeting of the American Society of Agricultural Engineers, at Lake Tahoe, Calif., June, 1926.

[1]Investigator for the Washington Committee on the Relation of Electricity to Agriculture. Mem. A.S.A.E.

[2]Wenatchee "Daily World," July 19, 1912. Other articles on stationary spraying are: "Western Fruit," December, 1922, and March, 1923; Washington Experiment Station Bulletin, by O. M. Morris; Wenatchee "Fruit Grower," March, 1923; "Country Gentleman," June 13, 1923; "American Fruit Grower," February, 1925; "Western Fruit," June, 1925.

(Left) This view shows a stationary spray plant with electric motor geared to the pump. The concrete agitator tank stands just back of the pump. (Right) This view shows the overhead piping system that connects with the central pumping plant

voltage, but when the voltmeter was put on it showed a drop of only about 5 to 7 per cent.

For the dormant sprays the effectiveness seemed to be as great with 275 to 300 pounds as with 400 to 450 pounds pressure. Twigs were broken off in the tops of the larger trees and when studied under an ordinary reading glass the lime sulfur seemed to be as well distributed in one case as in the other. However, this is apparently not true when the trees are covered with foliage. For the calyx and cover sprays the better the fog, the more effectively the spraying appears to be done. It was found that a better fog was obtained with the higher pressure. Also the fog could be shot somewhat higher into the trees with the higher pressures which seems to add to the argument in favor of the high pressures.

Where the economical limit in pressure is I am not prepared to say. The following extract from A. R. Chase's[3] report of a survey made last summer apparently justifies the higher pressures:

Pressure	Number reporting	Good control	Approximately
225 lbs. or less	32	9	28 per cent
250 to 325 lbs.	110	45	41 per cent
330 lbs. or more	69	38	55 per cent

"It would appear that the chances of securing good control are twice as good where the pressure is increased from 200 to 400 pounds. The orchardist who puts in a new stationary outfit and cuts his percentage of wormy apples from fifty to five the following year, and to one and one-half the third year is outstanding but not unusual. We would especially caution the grower investing in a stationary outfit to buy one which will give him plenty of pressure. An extra outlay of a few dollars for this purpose will give him an outfit which will reach all portions of the tree when a few years' growth has been added and will prove economical in the end."

Pipe losses with spray material are not especially easy to obtain in the field nor do we feel that the data which we have secured is accurate enough to justify publication. The viscosity of spray material is evidently greater than that of fresh water, therefore the pipe friction would naturally be expected to be higher, but the values ordinarily used are taken from water-friction tables.

A few tests were made on spray guns mostly from the standpoint of the quantity passing through the gun with different sizes of orifices. In order to obtain best results it should be possible to operate all the common makes of guns with the various sizes of disk opening. We found that the amount of material passing through the gun when wide open was the same as when screwed down for full fog.

The methods of piping the orchards are numerous. The majority of systems are dead-end, but some were found with returns. One return system was so arranged that the return as well as the main is under pressure when spraying; the return is cut off the pressure line and into the tank only for washing out the system. This forms a parallel path to the guns and reduces losses quite materially. In the case of the dead-end system where the pump is at the highest point, the system is drained by opening the ends of the laterals. If the pump is at the lowest point, the system is frequently drained back into the tank and the trees nearest the pump sprayed last. This system is washed by pumping the water through.

I do not know how long a plant will last under ordinary service. Much depends upon the care it receives and the condition of the water. Some farmers use settling tanks. This settling tank has a capacity equal to that of the agitator tank and is filled while the agitator tank full is being sprayed out. A large valve near the bottom of the settling tank permits of its being emptied into the agitator tank in about five minutes. This not only helps to protect the pump from grit and other foreign substances but speeds up the filling of the tank.

The question naturally arises as to the cost of installation and maintenance of these plants. The first cost of these plants for an orchard up to ten or fifteen acres is between $1000.00 and $1400.00 installed. The portable rig for this same duty sells in Wenatchee for about $1200.00. Farmers report that with the stationary outfit they are able to do their spraying in about one-half the time required with the portable. The wear and tear on the machinery is less and the ditching in the orchard is not damaged. The irrigation water is not turned off for spraying as was practically necessary with the portable rig.

[3]Mr. Chase is county agricultural agent in Chelan County, Washington, in which is located a large part of the Wenatchee orchard district.

Farm Electrification in Italy

AGRICULTURE in Italy is under the handicap of either too much or too little water. In some districts the seasonal rains would be quite sufficient if the water could be used to benefit the crops, but instead it flows away leaving the soil dry. In other places the land is swampy and the excess of water must be removed before it can be efficiently utilized. As a result, even under the most favorable conditions, Italy, which is a wheat-consuming nation, is obliged to supplement its own wheat production by heavy imports. The wheat crop sometimes varies as much as 40 per cent, although the area under cultivation remains practically unchanged.

In northern Italy, where the water supply is better than in other parts, the greatest progress has been in the use of electricity. A network of transmission exists and the availability of electric energy is greater during the summer months when agricultural activity is also greatest. In this section of the country electricity has been applied to many purposes including pumping of water, plowing, harrowing, threshing and fodder cutting.—U.S.D.C. "Commerce Reports"

Agricultural Engineering in Australia*

By Dudley T. Angas[1]

AUSTRALIA is a continent three million odd square miles or a little over 1920 million acres in area. In other words, it is about the same area as the United States. It comprises the five states, on the mainland, of Western Australia, South Australia, Victoria, New South Wales, and Queensland. The total population of this 1920 million acres is at present about five and one-half million people.

South Australia, which is the middle state of the five, has farming conditions which apply generally to the other states. Its area is 380,070 sq. mi., or over 242 million acres, of which area approximately 3½ million acres are being cultivated at present. This land under cultivation is nearly all situated in the area within 150 to 200 mi. of the coastline, the majority of which has an average annual rainfall of from 15 to 25 in. In some locations they have more rain than this. In the particular section where my property is situated the rainfall averages about 29 in.

The population of South Australia is in the neighborhood of 560,000 persons, which, with an area of 380,000 sq. mi. means an average of about 140 persons to each 100 sq. mi. The majority of the area of South Australia, however, is as yet undeveloped and uninhabited through lack of rainfall, and, in most cases, through the total absence of any other kind of water supply.

Australia is a new country, being only about one hundred years old, and its development due to several factors has been necessarily slow. These factors are principally as follows:

(1) Australia's position on the globe. Being farther away from other centers of civilization and commerce than any other country, the question of populating Australia by immigration is more difficult than in any other country.

(2) It is growing more and more difficult, in all parts of Australia, to get the men away from the towns and centers of population and on to the land.

(3) In the development of a new country, such as Australia, the government is faced with the difficulty of making ends meet, and there is a general lack of good roads and railway services. Therefore, a great many farms are necessarily isolated. Again, the use of automobiles and trucks, although increasing largely from year to year, is not on anything like the scale that it is in this country.

Farms vary greatly in area. This condition is natural, owing to the widely differing soil conditions. For the farmer in average locations 300 to 400 acres is the usual amount under cultivation each year, but, in many cases, this increases to 1,500 and 2,000 acres.

Wheat is at present the most widely grown crop, both for grain and for hay. Barley, oats and peas are also largely grown. Alfalfa is coming rapidly to the fore as a fodder crop, and is found to give excellent results when used in rotation with other crops over a period of years.

Wheat growing in the majority of cases is accompanied by sheep farming, the two operations working in with each other very well in parts of Australia. The total number of sheep in South Australia at the present time is approximately seven millions.

Rainfall conditions in most parts of Australia are such that only one crop per annum can be taken from the land. Plowing is usually begun about May or June, when the first winter rains come, and is continued right through the winter until as late as September. Deep plowing or subsoiling has not as yet been found necessary, or even advisable. In most parts a depth of from 4 to 6 in. is customary. This operation is usually done with a moldboard plow of five or six eight-inch bottoms. The disk plow is not used in many parts of Australia, owing to the heavy nature of a great deal of the soil, which tends to roll round the disks into one solid ball.

After plowing the land is given a thorough cultivation, as a rule to about the same depth as it has been plowed, this being done with a cultivator of the tyne or share type. Each tyne cuts from 4 to 5 in., and the implement carries from 15 to 17 tynes.

Traction for plowing and cultivating is usually provided by a team of from 8 to 10 horses or by a tractor of about 25 drawbar horsepower capacity.

After cultivation the soil is broken down to a finer tilth and levelled by means of harrowing, and the land is then allowed to lie fallow through the summer months, from December to about April. As soon as the first fall rains come, the land is once more cultivated and harrowed and then the seed is sown, together with the amount of manure deemed best for that particular soil. A light harrowing following seeding insures covering of the seed.

The varieties of wheat sown in Australia are somewhat different than those sown in this country, but produce a good, hard milling wheat.

Drills are much the same as those used in this country. In fact, several makes of American drills are used in Australia. Both the hoe and disk type, usually of the 16 or 17-hoe size, are used. The quantity of seed and manure sown per acre for wheat is usually about 80 to 90 lb. of seed and from 100 to 112 lb. of 45 per cent superphosphate manure. A less amount of manure is sown on virgin soil.

During the operation of seeding, one is occasionally hampered by heavy rain, which, in certain parts, makes the country too boggy to allow any work being done on it, and as I have found from personal experience, work done at such times is not at all profitable. Therefore it pays to get the seed in as early as is consistent with the season. However we all get bogged at times, both with tractors and with horses.

The wheel tractor, even with the most efficient widewheel surfaces and lugs, I find quite impracticable to work on my own type of land. Even the track layer type, with wide tracks, sinks out of sight in certain wet seasons.

The crop which has been drilled between March and June will be ready to cut for hay about November. A good average yield will be from 4 to 4½ tons of hay per acre. This is cut with binders cutting from 6 to 8 ft. and is then left in shocks to dry before carting and stacking in the usual manner.

Harvesting is usually begun about the second or third week in December, when quite often we have the hottest weather of the season. This operation is entirely done with combines, mostly of the ground-wheel-drive type. This type of machine has been in operation in Australia for at least 20 years. The engine-driven combine is just beginning to find favor there.

Most of the crops in Australia average between 4½ to 5½ ft. in height, and a fair yield for a large crop is about 30 to 35 bu. per acre, though this is often exceeded. I have known many crops to go 50 to 60 bu. to the acre.

In South Australia the handling of grain is entirely by means of the three-bushel sack, the bulk handling method not having, as yet, been introduced there. It is though being seriously considered by the government and is already in operation in Victoria and New South Wales.

Where large construction work and machinery is as costly as it is at present in South Australia, the installation of a bulk-handling scheme for a sparsely populated territory is an expensive matter.

Tractors for agricultural work in Australia have, during the last two or three years, become very much more common than formerly, when they were regarded with a great amount of skepticism. The Australian farmer is beginning to realize the value of labor-saving machinery of all types. Many of the more conservative, however, still swear by Dobbin.

Labor is hard to get in Australia, especially on the farm. When one does get it, it is, as a rule, most unreliable and inefficient. I speak from the power farmer's point of view. Added to

*Paper presented at a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers at Berkeley, Cal., May, 1927.

[1]Wheat farmer, South Australia. Mem. A.S.A.E.

this, as stated earlier, Australia is further away from the world's markets than any other producing country, and therefore to compete with other countries in these markets, she has to produce goods at a lower cost.

Here is an opportunity for the agricultural engineer, but there are many obstacles to be overcome. All machinery entering Australia is taxed, the object being to foster the establishment of local manufacturing industries. With American machinery, for instance, this ranges between 45 to 60 per cent. Add to this the cost of packing for export, freight, and retailer's profit, and the farmer has quite an expensive machine by the time it reaches his hands. Then for tractor fuel, in this country you pay about 11 cents per gallon and for lubricating oil about 60 cents per gallon, while in Australia tractor fuel costs from 40 to 42 cents per gallon and lubricating oil costs slightly over a dollar per gallon. However, even with these drawbacks, power farming has been successful.

In each state there is a state-owned agricultural college. These colleges do not have accommodations for very many students. Those who go to them get a good agricultural education, but, as yet, very little engineering instruction is given them compared with the amount taught in similar institutions in the United States. These colleges do not cooperate with the farmers in the same manner in which the agricultural schools in this country do. The farmer, therefore, is handicapped in adopting modern engineering practices.

There are, nevertheless, a large number of men on the land in Australia, who realize the value of modern agricultural engineering science, and it is on their behalf that I have been considering the suggestion made to me by Mr. Olney and others of this Society, that I should endeavor to organize a section of the A.S.A.E. in South Australia which could be the nucleus of a future Australian society of agricultural engineers. I believe, from an agricultural standpoint, that an interchange of views between this country and mine could be of great mutual benefit.

A Short Course for Rural Electric Service Men

By Truman E. Hienton[1]

FORTY-ONE rural electric service men from five middle western states have a better idea of the relation of agriculture to electricity and just what a farmer can and cannot use, as the result of attending a rural electrification short course held at Purdue University, October 18 to 21. The course, the first of its kind ever given in the United States, was designed to acquaint the electric service men, already familiar with their own products, with some of the farmers' problems and give them definite information on just what electricity is capable of doing for the farmer.

The entire course, consisting of lectures and demonstrations, was planned to make it as helpful as possible, and the rural service men not only were given the information needed but also were shown equipment at work about the university farm, in the agricultural engineering department of the experiment station, and about West Lafayette.

One general idea expressed by Purdue men and electric men alike was that the farmer should be sold only that equipment which will give him efficient service. The idea was well put by Dr. G. I. Christie, director of the agricultural experiment station, who said in the course of an address to the group:

"The rural service man must not only know his equipment but he must know where it will serve most efficiently. The farmer who buys a machine which eventually he cannot use because it does not exactly fit his needs, will prove a stumbling block to electrical expansion in his territory. The successful rural electric service man of the future must be an agricultural specialist as well as an electrical expert."

The qualifications for this type of man were well defined by G. C. Neff, a former chairman of the Rural Service Committee of the National Electric Light Association in an address in which he said:

"Inasmuch as this development means an application of electric power to farm operations the man at the head of a rural service department should be a man well trained in agricultural matters. An agricultural engineer in my opinion is the one best qualified for this job. The agricultural engineer has had a general engineering training, and it is a rather easy matter for us to give training in the public utility business because we understand that business."

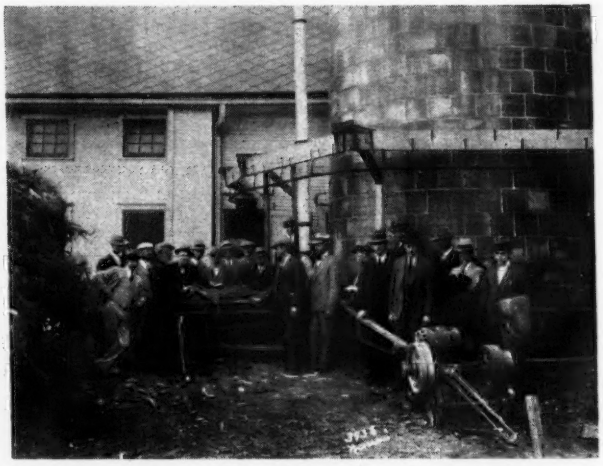
Various staff members of the Purdue University agricultural experiment station, specialists in their respective fields, spoke on the value of feed grinding, showing the necessity for grinding the ration for dairy cows, the value of feeding an all-ground or all-mash ration to growing chicks, and the part grinding or hulling occupied in preparation of hog rations. Prof. F. W. Duffee, agricultural engineer of the University of Wisconsin, discussed feed grinders and their power requirements preceding demonstrations of several electrically driven grinders in the agricultural engineering laboratories.

Poultry husbandry men discussed electric incubators and brooders and the use of artificial illumination for increasing winter egg production prior to visiting the university and commercial hatcheries to inspect the latest in electric incubators and brooders and methods of lighting poultry houses.

Discussions of milking machine and cream separator operation as affected by electric drive were led by staff members in dairy husbandry and followed by demonstrations, including an animal groomer used daily on the university herd.

Agricultural engineers contributed to the program by discussing general-purpose farm motors, shallow and deep well electric pumps and electric pump jacks. Considerable interest was manifested in the use of a 5-hp. general-purpose motor used to drive a 13-in. ensilage cutter elevating silage 40 ft. and also in various types of electric water pumps.

Valuable contributions to the program were made by T. A. Wood, agricultural engineer of the California Committee on the Relation of Electricity to Agriculture, on electric wiring for the farm, and by Miss Eloise Davison, home economics specialist of the National Electric Light Association, on requirements of electrical equipment for the farm home.



Rural electric service men watching a demonstration of cutting ensilage with a 5-hp. motor and 13-in. cutter, during the Purdue rural electrification short course

[1]Agricultural engineer in charge of rural electrification, Purdue University. Assoc. Mem. A.S.A.E.

Professional Agricultural Engineering Education*

By Charles E. Seitz[1]

THE main object of professional agricultural engineering education is the training of engineers for the field of agriculture. The object of non-professional agricultural engineering education is the training of agricultural students in the mechanical phases of agriculture. The existence of these two distinct classes of instruction in the colleges has tended to confuse the general public as to just what agricultural engineering is. There should be a clear distinction between the two types of instruction. The agricultural engineer must be as well trained in the fundamentals of engineering as the engineer in any other branch. In addition he must have a broad scientific and business training and a thorough knowledge of the fundamental principles of agriculture.

The agricultural engineering curricula at the various institutions differ to some extent, due to local conditions and limitations, but most of them agree as to the amount of fundamental engineering subjects required. At the Virginia Polytechnic Institute we have passed through the transitional period in organizing our professional course. We now have our curriculum as well outlined as is possible under present conditions. We have endeavored to include a variety of subjects of value to the agricultural engineer without sacrificing any of the fundamental engineering courses. Our graduates are just as well equipped from the standpoint of fundamental engineering knowledge as the graduates of any other branch of engineering at our institution. They have the additional satisfaction of a broader training.

Our department of agricultural engineering is administered under the school of agriculture. There may be some advantages of being under the joint administration of the schools of agriculture and engineering, but where it is necessary to choose one school, I believe there is more to be gained by selecting the school of agriculture. The closest possible contact and sympathy with agriculture is essential if agricultural engineering is to function properly. This contact and sympathy is best secured under the school of agriculture. An outline of the courses required in our agricultural engineering curricula accompanies this paper.

In order to permit all engineering students a year in which to find out definitely what special line they desire to follow, the first year of all engineering curricula is made uniform. Courses in "Introduction to Engineering" are given to help students decide this question. We have an opportunity in this introductory course to talk to the entire freshman class at least twice a year. As a result we usually get several additional students at the beginning of the sophomore year. Last year six changed to agricultural engineering. The agricultural engineering enrollment in the freshmen year, therefore, is not a definite index as to the number of sophomores we will have.

Since we have strengthened our curriculum in fundamental courses, we are getting a much better class of students. There is also a great deal more respect for the agricultural engineering curriculum along the engineering students as a whole, as they know it is fundamentally an engineering course.

I believe that a well-outlined professional agricultural engineering curricula offers a broader training than it is possible to receive in any other engineering curriculum. An agricultural engineering education should be especially attractive and valuable to the young man raised on the farm and who has the engineering type of mind. Such a course enables him to capitalize on his early experiences, and the background of farm life will be invaluable to him in the profession of agricultural engineering.

Ten educational institutions in the United States and Canada are now offering regular four-year courses leading to the degree of bachelor of science in agricultural engineering. In at least four other institutions a professional course is pending and will probably be offered in a short time.

You are possibly familiar with the report made by Q. C.

Curriculum in Agricultural Engineering at Virginia Polytechnic Institute Leading to the Degree of Bachelor of Science in Agricultural Engineering

FIRST YEAR	I	II	III
Inorganic Chemistry	3(3)	3(3)	3(3)
Inorganic Chemistry Laboratory	4(1⅓)	4(1⅓)	4(1⅓)
Introduction to Engineering	1(⅓)	1(⅓)	1(⅓)
English Composition	3(3)	3(3)	3(3)
Drawing	4(1⅓)	4(1⅓)	4(1⅓)
Algebra	3(3)	3(3)	
Trigonometry	3(3)	3(3)	
Analytical Geometry			6(6)
Descriptive Geometry	3(1⅔)	3(1⅔)	3(1⅔)
Military (basic course)	3(1)	3(1)	3(1)
Hygiene	1(⅓)	1(⅓)	1(⅓)
Credits each quarter	18	18	18

SECOND YEAR	I	II	III
Farm Implements	5(3)		
Agricultural Surveying and Drainage			11(4⅓)
Dairy Engineering		3(3)	
English and American Literature	3(3)	3(3)	
Agricultural Geology			3(3)
Engineering Drawing	4(1⅓)	4(1⅓)	
Calculus	3(3)	3(3)	3(3)
Shop Practice	4(1⅓)	4(1⅓)	4(1⅓)
Military (second basic course)	3(1)	3(1)	3(1)
Physics	4(4)	4(4)	4(4)
Physics Laboratory	4(1⅓)	4(1⅓)	4(1⅓)
Credits each quarter	18	18	18

THIRD YEAR	I	II	III
Internal-Combustion Engines	8(4)	6(2)	
Farm Structures		5(3)	6(2)
Advanced Agricultural Surveying			7(3)
Soils		3(3)	
Farm Crops			3(3)
Applied Mechanics	3(3)	3(3)	3(3)
Mechanical Engineering Laboratory	6(2)		
Hydraulics			2(2)
Principles of Econmics	3(3)	3(3)	
Elements of Electrical Engineering	2(2)	2(2)	
Shop Practice	6(2)		
Business Law			3(3)
Non-technical Electives	2(2)	2(2)	2(2)
Credits each quarter	18	18	18

FOURTH YEAR	I	II	III
Marketing Farm Products		3(3)	
Drainage and Irrigation Engineering	8(4)		
Agricultural Engineering Problems		1(1)	1(1)
Rural Architecture		4(2)	7(3)
Automobiles, Trucks and Tractors		8(4)	4(2)
Rural Sanitary Equipment		5(3)	
Rural Electrification			4(2)
Farm Management		3(3)	3(3)
Salesmanship	3(3)		
Personnel Adminstration			2(2)
Electrical Engineering Laboratory	6(2)		
Agricultural Journalism	3(3)		
Public Speaking	2(2)		
Business English			3(3)
Non-technical Electives	2(2)	2(2)	2(2)
Electives	2(2)		
Credits each quarter	18	18	18

NOTE: The Roman numerals, I, II, III, represent fall, winter and spring quarters. The number outside parenthesis in quarter columns represents the number of hours required per week in a course, and the numbers in parenthesis represent the credits allowed for the course, as 3(3) represents "three hours, three credits."

*Paper presented at a meeting of the Southern Section of the American Society of Agricultural Engineers, at Atlanta, Georgia, February, 1927.

[1]Professor of agricultural engineering, Virginia Polytechnic Institute. Mem. A.S.A.E.

Ayres, of Iowa State College, entitled "Educational Statistics and Occupation of Graduates in Agricultural Engineering." This report, dated February, 1926, gives data, collected by Prof. Ayres as a part of the work of the Committee on Agricultural Engineering Education, of the American Society of Agricultural Engineers, that have a direct bearing on professional agricultural engineering education. This report should be in the hands of those especially interested in this subject. Copies may be secured from the secretary of the Society.

The engineering field in agriculture is, I believe, greater than that offered by any other industry. Dean Mortimer E. Cooley, of the University of Michigan, a recognized authority on engineering education, recently made the statement that "Agriculture has opportunities in engineering which, in their bearing on the welfare of the nation, are second to none in importance, for nothing is of greater importance than the feeding and clothing of our people."

Engineering Service For Farmers

By L. J. Fletcher[1]

AGRICULTURE is fast becoming a strictly manufacturing industry. However, as compared with other types of manufacturing, it offers many peculiar situations. There is, as a rule, but one turn-over of product a year and in some cases, such as dry farming, but one in two years. The factory is located to a large extent outdoors, with little or no control over many of the important conditions affecting the product, such as temperature, winds and moisture. The industry, however, has one great advantage in that its product is absolutely a necessity, for most of us like three meals a day.

The place of the engineer in agriculture is rapidly increasing in importance. As President Coolidge recently stated in his message to Congress, "Our present state of prosperity has been greatly promoted by three important causes, one of which is economy, resulting in reduction and reform in national taxation. Another is the elimination of many kinds of waste. The third is a general raising of the standards of efficiency. This combination has brought the perfectly astonishing result of a reduction in the index price of commodities and an increase in the index rate of wages. We have secured a lowering of the cost to produce and a raising of the ability to consume."

The engineer is primarily concerned with elimination of waste and reducing of production costs. I shall undertake to outline briefly the methods for securing engineering service on the farm. This service may be utilized directly, such as in laying out of drainage systems, surveying land for irrigation structures, or the planning and erecting of farm buildings; or the service may be rendered indirectly through the design and construction of farm machinery and equipment.

In the past many people have failed to realize the importance of good engineering to the farmer. No one doubts the engineering character of the design of a large building, bridge or locomotive. Here the work is apparent in one large mass. Engineering in agriculture is often spread over a large number of identical units. For example, at the University of California, members of the agricultural engineering division spent considerable time and thought in working out of a suitable form for a farm septic tank. This form was designed so that it could be easily taken down without damage to any of its parts. It was also designed to be economical of lumber. People would doubt the engineering value of such a service because the amount of money involved was small, but when one considers the fact that there are ten thousand of these septic tanks installed on the farms in California at a cost of from $10 to $50 less than other types of tanks available, the total saving is considerable.

The same applies to the design of a plow, where careful study will eliminate a few dollars in its expense of manufacture, or by correct design lower the draft of the plow or its rate of wear.

However, at this time we are mostly concerned with the service of the individual agricultural engineer as it is made available to the farmer. I have divided this service into three main classes. The first is that rendered by state and federal agencies, such as the agricultural engineering divisions of our universities and the extension specialists. In general the work of these men is made available to the farmer without cost. While there are perhaps no definite rules as to the nature of their service, it is generally understood that they are concerned mainly with community problems and those things which either make farm life better or affect the efficiency of producing crops. However, there are undoubtedly many times where the service rendered appears to be of an individual character. In many such instances, however, the spread of influence from this one case to others in the same community is the ultimate goal of the work rather than service to the one farmer. This has proven to be the case in such projects as the building and installing of the septic tank on the farm, where one demonstration is attended by many of the neighbors. In some cases the forms built for this one demonstration have been used as many as forty times.

In a similar way the advice and direction given a poultry farmer in the building of a laying house, or complete layout, influences the construction of other such structures in the community.

Tractor schools are intended not so much as a means of repairing or adjusting the tractors at the time as to impart information and skill to those attending so that they may continue to maintain their equipment in better condition.

The second method for extending agricultural-engineering service is through manufacturers' or dealers' agencies. For example, manufacturers of barn equipment will aid in the design of farm buildings. The Portland Cement Association renders considerable service in the design and building of concrete structures for the farm. Lumber associations render similar service for wooden structures. Many manufacturers of farm equipment of various kinds maintain a very efficient service department for advising any who inquire. In these cases there is seldom a direct charge made to the farmer for service. It is apparent, however, that the consumers of the product must pay for this service. Undoubtedly the increased price with the larger companies is very slight when spread over their entire output.

The third way for making available to the farmer agricultural-engineering information is through the consulting agricultural engineer. This system is well established in other lines of engineering. There is no doubt but what any farmer would prefer to have the complete, individual attention of an agricultural engineer on his problems until the job is finished, rather than have to depend on public agencies, which may not be able to give him all the help he wants or may perhaps have to withdraw help because of lack of public support.

As agriculture develops, a more complicated equipment and as the investments become larger, there is becoming evident the increased demand for the services of the consulting agricultural engineer. At the same time the field is so varied and complex that one man could hardly render all types of service. In fact, in most states there are from four to twelve men in the state college or university, all handling a different phase of the work. It is not my purpose, however to attempt to do otherwise than briefly outline the problem. I suggest, however, that the American Society of Agricultural Engineers give every attention to the logical and proper development of the field of the consulting agricultural engineer.

*An address before a meeting of the Pacific Coast Section of the American Society of Agricultural Engineers, at San Francisco, December, 1926.

[1]Agricultural engineer, supervisor of agricultural sales, Caterpillar Tractor Company. Mem. A.S.A.E.

"Are Farm Buildings an Expense or an Investment?"

NOTE: This discussion followed the paper of this title by J. L. Strahan presented at the meeting of the Structures Division of the A.S.A.E. at Chicago, December, 1927, and published in the January, 1928, issue of AGRICULTURAL ENGINEERING, (Vol. 9, No. 1).

A. W. CLYDE[1]: I have looked over some of Mr. Strahan's figures rather carefully and I think, while I don't know anything about the feeding costs, that he has leaned over backwards. He has put the costs on the cow so high as to make a rather unfavorable case for her. For instance, in the depreciation of cows in the table, I understand a man buys every cow that goes into his herd. He doesn't raise any calves to replace them.

MR. STRAHAN: I figure the cow is so much money to him whether he buys her or raises her.

MR. CLYDE: That would provide for his going out and buying her and also provides for all his costs.

MR. STRAHAN: That provides for his replacements by actual purchases.

MR. CLYDE: Now our dairy man tells us that is poor dairy business, that no one should buy all his cows. His idea is that he can raise them cheaper.

MR. STRAHAN: In the paper there are two places for estimating depreciation.

MR. CLYDE: But you have made this too big, if anything. Another thing is this matter of figuring dairy barns at $250 or $300 per cow. We are talking pretty high bookkeeping when we are talking about such figures as the cost per cow. I think, just as Mr. Strahan hinted, that we are doubling some of the items. For instance, we are probably charging feed at market value and yet we are charging all that hay mow space against the cow. If we went out and bought our hay and feeds at market price, we would need simply a one-story barn and a very inexpensive shed to supply two days' feed. When we charge all the hay mow space and the feed at market price, we are doubling up on costs.

Then, also, the space in the barn taken by calves. I claim that space ought to be charged up against the calves and not against the cow. There is another item which is doubled when we charge the entire building cost up against the cow. If you would eliminate those items and charge them where they belong the cost of buildings might drop down, even with very good buildings, to less than $200. And we know farmers are getting along with buildings that cost them much less per cow when they charge the feed cost where it belongs and don't double it.

And if we charge all this cost against the cow we are going to get back the price of the calf, which will be nearer what Mr. Strahan assumed. And in the matter of feed, if it is economical to buy it and store it in a cheap building, why not store it in the building outside in the first place? If it is more economical to store it in an open shed outside when we buy it, why is it not more economical to store it in a shed when we raise it?

You could buy feed as you needed it. You wouldn't have to buy a year's supply at once and provide an expensive storage bin. When you charge feed at market price that should include the storage of the feed up to the time it is consumed.

MR. STRAHAN: If I understand you, I think I have the same idea. The cost of housing one's own feed is charged as a cost value in the production of the feed and not the milk.

Perhaps you have the wrong impression. The cost of the cow is merely an effort to get a statement of the cost of the farm buildings in terms of some convenient unit, and it is easier to take it in the terms of a production unit, because really the whole outfit is a business in itself. The entire business has to take care of the cost of storing, grain, hay, and silage, and even has to take care of the milk after it comes from the cow.

MR. CLYDE: Yes, that is a convenient unit. But we ought to realize the share of the building cost which is charged against the cow which is not properly her part of the $300. I think the $30 item of buildings ought to be reduced to $20.

CHAIRMAN KAISER: Apparently he has made the worst possible case for the cow. The cow is the producing unit from which we get the salable products. Maybe we ought to charge it against her.

MR. STRAHAN: Even though the cow is the producing unit, I do not think it is right to charge twice for the same thing. Charging the market value for feed and making her pay for the buildings which house it is charging twice.

JOHN SWENEHEART[2]: Mr. Strahan's statement and his sheet of curves seem to me just to fortify the position that I took with respect to the relation between these things. It was my idea that there was a relation that we must establish between these, and I want to go on record in the Society as not being in favor of cheap construction and an increase in labor, but realizing one or two big principles I think we must take with us.

Somewhere in this discussion there should be stated clearly some basic conditions; otherwise it is possible that the wrong impression will be given. I refer to what a farmer receives in the way of production from his dairy herd. This, of course, is based on two things: (1) Price per pound of butter fat per pound or hundred pounds of milk, and (2) the quantity of milk produced by dairy cows.

Mr. Strahan's conclusion was based on cows of high production. I would point out that cows of high production, as mentioned in his paper, do not exist in nature and cannot be produced quickly. According to the rate of improvement in

[1]Extension associate professor of agricultural engineering, Iowa State College. Assoc. Mem. A.S.A.E.

[2]Professor of agricultural engineering, University of Wisconsin. Mem. A.S.A.E.

Agricultural engineers are giving serious attention to the problem of farm building costs in relation to production and income. Cheap construction is not to be tolerated under any circumstances. Building to raise the efficiency of the worker, to increase the economy of production and marketing, and to provide other essential shelter requirements is the real goal, in a nutshell.

the biological productive capacity of cows, the majority of our animals cannot be brought up to this point for probably a hundred years. Denmark's production, under her intensive agricultural production, is 5,556 lb. This means then that there is a biological capacity and that our engineering data must be founded on the limits in this regard. After the millions of dollars of dairy extension and work that has been done in this country during the last 25 years, production has not increased very largely. The average production per cow in this country will fall below 6,000 lb. of milk. That is a condition that now exists. The increased production from the cows, without the use of this slaughter house which he mentioned, is not forthcoming.

The second point is the matter of price per pound. Anyone may check these figures. Mr. Strahan based his conclusions on a price of $2.74. In my opinion it would not be correct to assume this figure as the price received for American dairy products. Allowing for by-products of the dairy such as skimmed milk, calves, and manure, the average amount received per hundred pounds by American farmers, not on the basis of whole milk alone, but on the basis of butter, cheese, whole milk, and condensed milk, comes near $2.25.

It seems to me that Mr. Strahan's figures are rather too optimistic, because farmers are not making the returns set forth in his paper, neither is it physically possible for them to do so in this generation unless some profound change takes place.

This chart to be accurate from the point of view of the farmer who is now on the land should have the section, rent for buildings, $30, and, by the way, that figure does not include many double charges. Mr. Strahan is right. There is no duplicating, and I believe he can stand by his figures. But he could buy better housing and possibly lower his feed and other costs. He could affect his total, but his proportion becomes still worse in the end.

This is based on a 30-cow barn. Not two per cent of the dairy products in this country are produced in 30-cow dairy barns. Most of the operators have 12-cow dairy barns. What are we going to do for the man who produces 75 per cent of the butter fat, milk, and cheese? He can not have a 30-cow dairy barn. He cannot consolidate that rapidly. What are you going to do for the farmers with the 12, 14, and 18-cow barns?

Suppose a man has built a 30-cow barn. He will actually have in it only about 22 cows. There will be 7 or 8 cows that are dry. And there are coming on the heifers he has figured in his upkeep-of-the-herd cost that are occupying a full cow space. This $30 rental charge has to be paid on the heifers, if he does not buy them. That proves he was right in stating his cost figures for cows in the first item there.

W. B. CLARKSON[2]: Before reading what I have written, I want to make two or three comments. In the first place, we cannot be and we should not be as much concerned with the man who is handling his farm inefficiently and who, if you please, is building a 36x80-ft. barn and only putting 12 cows in it, as we should be concerned with the man who is attempting to be more efficient and trying to make some money out of his farm.

I come from Steele County, Minnesota, and I do not believe there is a single farm in the county that has not its dairy herd. We have all kinds, from 12 cows up, and we have all kinds of conditions. In fact, I think Steele County from a dairy herd standpoint is a very fine cross-section of what we would find generally over the country. I know that from 75 to 85 per cent of the money in our banks is the farmer's money. Where did they get it?

In the limited time given me for the discussion of Mr. Strahan's paper, I shall stress the development of the past decade and a half and recall the attention of the members of the Society, as well as the public at large, to the work that has been done by various members of the Structures Division of this Society, which has been reported from time to time and is now more or less buried in the archives.

[2]Vice-President, King Ventilating Company. Mem. A.S.A.E.

Following Mr. Strahan's lead, I also shall "call a spade a spade" and put squarely up to the Standards Committee and the officers of the Society the fact that we do have sufficient data reasonably well digested from which the Standards Committee could form a set of recommended practices in farm structures, and urge that we should proceed to find ways and means for the publication of a manual without further delay.

Not over a decade and a half ago, there was a great scarcity of literature on the subject of farm structures, and this was especially true of ventilation, which must be considered as a vitally important part of the structure itself and which, if properly applied, becomes a permanent fixture in the superstructure, as is also true of the equipment which becomes a fixture of the floor plan.

The late Dr. Armsby's contribution to the literature of this Society just before his death and the wealth of data he left as a result of his life work is available to any student of farm structures, and from the Armsby records one could easily determine the approximate amount of heat one has to deal with in any stable. By a simple process of deduction it is easy to arrive at a reasonable coefficient for any material used in the construction of a stable as well as the amount of air space each animal may reasonably be expected to heat.

The notable work done by M. A. R. Kelley, M. C. Betts, and others of the agricultural engineering division of the U. S. Department of Agriculture, and the work done by F. L. Fairbanks, A. M. Goodman, and others of the rural engineering department of Cornell University, as well as the more or less notable research work that has been accomplished in the last decade and a half in various other directions, all of which is available to the students of farm structures, furnishes us now a wealth of literature and data on that subject, so that a bibliography of the general subject of farm structures in all of its phases, but especially the dairy barn, would at the present time furnish a formidable list and a wealth of fairly accurate data on most any of the questions involved. In fact, a great deal of this is recorded in the literature of our Society and this, in my opinion, will furnish sufficient information with regard to the proper kind and class of structure for every climatic zone in the United States and Canada. The farmers, however, have a right to expect—yes, to demand—that we develop a set of "recommended practices" in the various engineering phases of farm structures.

We must not have our minds confused as to the prerogatives of the architect as related to that of the engineer. You have no right to tell me the shape of my barn roof, architecturally, but I expect and demand of you that you stay on your own side of the fence and tell me how that roof should be built from an engineering standpoint.

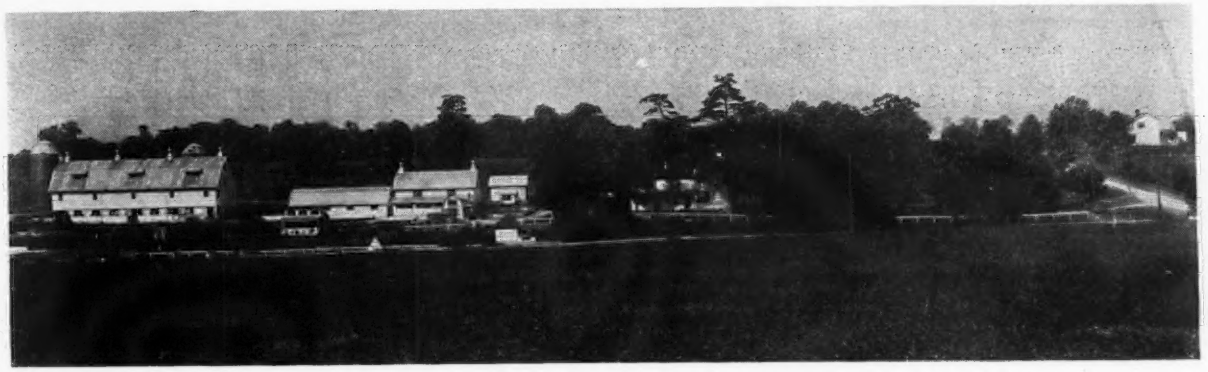
It is imperative that the Standards Committee of this Society should do something along this line. Suppose a recommended practice established by this Society should in the light of later discoveries need to be modified or rescinded, what of it? Does any one know of any standard practice, especially in structural work, that remained a standard without change for very long?

If Swenehart in the hour of his discontent and Strahan in the frank and free flight of his analysis have in juxtaposition started something that will result presently in a manual of this Society that will give us a set of recommended practices for farm structures that we can lay hold of and make use of, they will have, together, accomplished a wonderful piece of work.

We of the Society are supposed to be associated together for better service and we actually find ourselves working at cross purposes whether we want to or not. We of the so-called commercial group cannot wait; we must do something. Each according to his judgment must render his best service now to his client. He cannot wait on the Standards Committee or anyone else.

A continued delay in getting out our manual will make the situation more and more acute as time passes, which, instead of cementing together the fraternal spirit and a consequent development of the esprit de corps that should exist in this Society, will delay this natural advancement and our service to the public will be hindered.

"Not how cheap, but how good." That is the real ques-



In farm building construction agricultural engineers must work out the most economical means for meeting actual physical requirements, let the costs be what they will

tion at issue. The older members of the Society will recognize this as a familiar phrase. In the old days our college extension service and research seemed to be tuned up to the question of how cheap Mr. Farmer could get away with structural work, and farmers' meetings were largely taken up with demonstrations to show the farmer how he might purchase cheap materials and use plans which cost him nothing, and erect the structure with home labor that he was led to think cost him nothing.

Instead of studying to increase his efficiency as a farmer, dairyman, poultryman, etc., and occupying his mind and his time to become more and more expert along those lines, naturally resulting in economy of production and marketing, he was influenced by propaganda to build his own silo, barn, or other structural work, which in a very large sense he was ill-equipped to do in an economical manner.

Happily, those days have gone and we are now finding our college extension service on a different basis. But the idea still seems to prevail in the minds of many that the costs of erecting farm structures are too high, when, as a matter of fact, the farmer is getting his structural improvements on the farm for much less money than the city man and skilled labor can and is being employed in farm structural work for less than that same labor is paid in the city.

After all, everything is merely relative; the finest and most pertinent thought in Mr. Strahan's paper is that which lays emphasis upon the relation of the investment in a complete, modern dairy barn to the investment in high-producing cows versus the "boarder."

R. N. CUYKENDALL[4]: Mr. Strahan has brought out some very good points on hog house construction. The question of a one or two-story hog house is a debatable one. The one-story hog house referred to is, no doubt, an attempt by some agricultural engineer to provide a cheaper building to meet a need of the average hog raiser. Some of the objectionable features of this house can be eliminated by the use of storm windows, supplementing the roof windows, and proper insulation on the under side of the roof.

If grain storage capacity is essential or if bedding can be placed on the second floor, or if the contour of the ground surrounding the building is such that the second floor might be used economically for the storing of machinery, then a two-story house might be preferable, even at a much higher cost than that of the one-story house.

The hog is concerned only with conditions produced in the house. If these conditions are better in one case than in another, it is easy to increase the number of pigs raised to maturity than would be the case where conditions were not correct—this applying, of course, to either type of house. Who can say whether the one or two-story hog house is the most economical and best adapted, without a thorough study of the conditions under which it is to be used?

Mr. Strahan has raised a point having to do with temperatures in dairy barns that should be given very serious consideration by agricultural engineers. In discussing the optimum temperature of dairy barns, Mr. Strahan has placed this at 35 to 45 deg. F. This is a debatable question and many of our most successful dairymen will disagree, contending that this is a lower temperature than should be maintained for maximum production.

Howard Greene, manager of the Brook Hill Farms, at Genesee Depot, Wisconsin, has many years of experience in producing milk at a profit and is one of the large whole-milk producers in the Chicago district. He says:

"Temperature control in a dairy barn is of great importance, but also subject to considerable variation due to seasonal conditions in Wisconsin. I think it would always be advantageous to maintain a temperature of at least 50 deg, but there are times when this will drop down to 40 deg., at which point there is quite a shrinkage in milk flow. I have felt that there was some room for improvement in the cost of dairy barns. It seems to me that, if more attention is put on insulation of a dairy barn and less on the quality of lumber used, we would be getting a good deal further."

D. L. Williams, of the Wern Farms, Waukesha, Wisconsin, started many years ago in the dairy business, having borrowed the first $25 with which to buy a cow, and his success is borne out by the fact that he has several hundred thousand dollars invested in the dairy business, all of which has been made from the small beginning. He says:

"The temperature should not fall below 45 deg. and should not get much above 65 deg. Either way beyond these points there will be a drop in production. This temperature can be maintained without much trouble with proper ventilation where cows are in stanchions."

Owen Rowlands, of the Keystone Farms, Waukesha, Wisconsin, states:

"We like to keep the temperature in our barns between 60 and 70 deg., and think we can maintain it in our type of barn. We have only one type of dairy barn, the one with storage above. It is easier to maintain a uniform temperature in winter, as well as in summer, in this type of building."

F. J. Southcott, of the Hollyhock Farms, of Dousman, Wisconsin, of whom it is said that he built the greatest herd of individual Holsteins in the country, has this to say:

"There is quite a difference of opinion in regard to how much the production of a cow is affected by the amount of expense invested in the barn in which she is kept. I would advise that the temperature of a building be kept at about 50 deg. F. This temperature can be maintained provided you have a good ventilating system which is carefully watched. The cows seem to do better with this temperature than at any other, the reason being that when a cow is on test she is fed high protein food, which creates a very high body temperature."

It will hardly be disputed that the Fern Dell Farms, Green Bay, Wisconsin, have the greatest herd of Guernseys on the American continent. A. W. Fox, manager, testifies as follows:

"In my opinion our barns at Fern Dell are by no means an expense, but they are rather an added investment. Much can be saved in the cost of labor through these well-arranged barns. The health of the herd is to be considered greatly by having barns that are good enough and equipped with proper ventilation. A barn of this kind, properly ventilated and

[4]Manager of ventilation department, James Manufacturing Company. Assoc. Mem. A.S.A.E.

Stimulated perhaps by the challenge that farm buildings cost to much in relation to the returns from the production processes to which they contribute, the accompanying discussion which followed the presentation of Mr. Strahan's paper was spirited and manifested an intense interest in the subject. Agricultural engineers are giving it most serious attention

arranged, naturally would be a good investment. A poorly arranged barn, poorly ventilated, would surely be a big expense in building up a herd.

"Our aim is to have as nearly a uniform temperature as possible throughout our test barn, which holds about thirty-four test cows that are being milked and fed four times a day. We do not like to have the temperature in this barn raised a degree above 65 deg., and a 60 to 65-deg. temperature in this barn is about where we aim to run the temperature. Heavy and frequent feeding keeps the cows working hard and possibily breathing a little faster than the natural breathing. They need plenty of fresh air."

It will be seen from the foregoing that temperature is a very vital factor in the minds of these sucessful and practical dairymen and breeders.

The figures presented by Mr. Strahan on the cost per cow in the modern dairy barn, at $250 per cow, could, no doubt, be reduced to some extent. We might build one-story barns, and the structure itself would cost less money. The labor in caring for the animals would cost more money and eventually no saving made but rather an expense incurred.

We might reduce the amount of insulation or material used in the structure of the stable part of the barn. Even though we were to leave but one single board inclosing the building, we could not reduce this cost more than twelve or thirteen hundred dollars, on the barn referred to by Mr. Strahan. By eliminating this expense, if we are to take the opinion of the men above quoted, it would prove to be a costly mistake. Placed on a rental basis, the additional insulation used in a proper stable wall construction would pay a bigger interest on the investment than any other part of the building.

This is truly an agricultural engineering problem that should be solved, and I would suggest determining:

1. The optimum temperature for maximum production in dairy barns

2. The proper wall construction to maintain this optimum temperature, taking into consideration the wall area per animal

3. The correct relative humidity

Research covering the points mentioned above would naturally lead into other related subjects that would, no doubt, prove of value to the industry. If we, as agricultural engineers, can determine conditions under which greater production can be secured, with our present cost of construction, we will be benefitting the industry more than to attempt to reduce the cost of building at any cost.

I do not believe that any agricultural engineer or practical dairyman could wholly disagree with Mr. Strahan, in view of the mass of evidence that well-constructed buildings in which to house livestock are a paying investment rather than an expense, and we, as agricultural engineers, should give most serious thought to these questions before suggesting any radical changes, and no change should be suggested that is not based on research.

HENRY GIESE[5]: If we should attempt to sacrifice our building construction we might get into other difficulties and might be jeopardizing our production. It would seem from what we have observed with chickens, contrary to some of our former opinions, that a chicken reacts quicker to temperature changes than to almost anything else. Take a chicken with a good physical condition and fail to feed her for a day or two and no great harm results. Then take her out of a warm room and put her into a cold room and you get almost an immediate reaction. So that I seriously question in my mind whether we can afford to run the danger of cutting the quality of the housing.

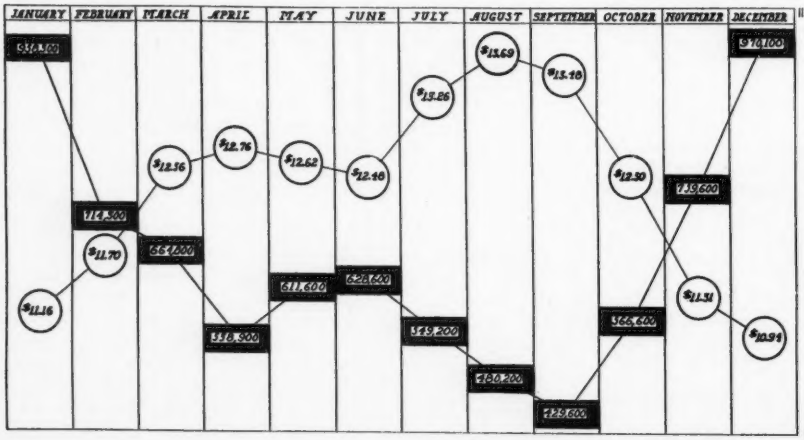
With regard to the number of cows which the farmer has, it has been the experience of industry, and it is working out that way on farms, that we must work in larger production units. Not long ago in an old copy of "Scientific American" I noticed that Fords sold higher than Cadillacs. Ford now has a very large production unit. The same principle holds true on the farm.

BRUCE RUSSELL[6]: Most of this discussion has been on dairy barns. Hog houses have been mentioned just once or twice and nothing definite has been given on hog house work. I wish I might be allowed to change the subject here and go into just a slight comparison of investments in cow barns and hog houses.

This chart I have here gives some information on the relation between receipts and prices of hogs based on the Chicago market. There are shown the average monthly hog receipts from the year 1913 to the year 1923 on the Chicago market, and the average price per hundred pounds for those months showing that except in two months we have the lowest receipts with the highest prices. Those are the only places where it doesn't hold true that when the receipts go down the prices go up. One hundred hogs weighing 200 lb. sold early in the season will bring $2,696. The same one hundred hogs sold later, with feed costs added all the way through, will sell in December for $2,188. So there is a difference there between the earlier hogs and the later ones

[5]Assistant agricultural engineer, Iowa Agricultural Experiment Station. Mem. A.S.A.E.

[6]Architect, Iowa Equipment Corporation. Mem. A.S.A.E.



This graph shows the average monthly hog receipts and prices per 100 lb., on the Chicago market from 1913 to 1923. One hundred hogs at 200 lb. sold in September for $2,696, and one hundred hogs at 200 lb. sold in December for $2,188. The increased profits due to early farrowed pigs were therefore $2669—$2188, or $508

of $508. That is a clear profit for farrowing the hogs earlier and selling them earlier, which can be done, of course, only by using better hog houses.

An extra good hog house that will rank in the same class with Mr. Strahan's $300 per cow dairy barn, would cost about $125 a pen. To raise these one hundred hogs, taking the average number of pigs saved per sow in the United States at about five and three-tenths—and we know if we have a good house the average hog-raising man is not going to be satisfied unless he saves more than five and three-tenths—we would need twenty sows and a 20-pen house to accommodate them. This 20-pen house at $25 per pen would cost $2500.

Our increase in profits of $508 by selling our hogs earlier, in September, when they could be farrowed earlier in the year, in five years would pay for this good house. Of course, there is some depreciation, but a hog house is going to last much longer than five years.

Mr. Strahan has charged a rental for each year of about ten per cent of what the dairy barn cost him per stall, or $30. If we charge a rental of 10 per cent per pen we will have to charge $12.50 to each sow per year. It happens that his rental charge is just about 10 per cent of what his 14000-lb. cow's gross earnings were. At ten per cent of the gross earnings of the hogs from this one pen, these hogs would have to sell at about $11.75 per 100 lb., and that is considering we only have produced five hogs from each pen. If a man can produce seven or eight or nine or ten pigs from a sow, which he should do, the return on our hog house and our hogs as against your dairy barn and your dairy cow would be somewhat higher.

C. P. TOBIN[1]: Mr. Strahan's paper indicates clearly that if the agricultural industry, as represented by the average farm with its present equipment and livestock, were held to the requirements of big business, it would come to a sad end due to disheartening mismanagement, that is, the effort to succeed without the modern equipment necessary to operate on a healthy basis. We are not now putting the farm to such a comparison but rather analyzing the situation to learn what additions to or changes in the present equipment, based on knowledge of animal needs, may be introduced to make it possible to operate the industry on a basis of more normal returns than it now enjoys.

Research work is the answer. The agricultural engineer is the man to whom we must look for the thorough analysis of conditions needed for animal welfare. In order to start right this work must be preceded by careful, painstaking delving into all kinds and conditions of animal environment as we now find them and as they may be created experimentally, to arrive at the fundamental requirements.

It has been said that only one-third of those operating farms are open to any readjustment in their farm operations. Only that proportion is willing and can be urged to look with favor upon progress, as represented by modern equipment, healthy productive animals and real management.

Even if that is true, it need not be long before the others are at lease shown the way to secure better conditions. All branches of farm science must and will cooperate to make this possible, utilizing all the research and effort that engineering skill and industrial help can offer.

As closer contact with city life is being brought about by better roads and automobiles, the farmer is in closer relation to marketing, banking, and city business methods. His opinion of "good enough" will be supplanted by the desire to employ all of the essentials to make his farm work more of a business. When he begins to reap the returns from his investments, made as the result of his awakened interest, we will not hear so much the "cost" argument, but of savings in waste, and improvements in soil, equipment, and livestock.

[1]Sales engineer, The Celotex Company. Mem. A.S.A.E.

Steel For Long Wearing Harrow Disks

By A. H. Hoffman[1]

PEARLITIC manganese steel which has lately come into extensive use for the manufacture of vital parts in several high quality automobiles has been tried out with fine results for the making of harrow disks. Some tests made at University Farm, Davis, Calif., had as their object to find a material that would wear less rapidly, that would hold a keen edge longer, and that would neither burr nor break. The comparison disks were of the ordinary open-hearth carbon steel in common use for a number of years. This steel has 0.85 to 1.00 per cent carbon and 0.70 to 1.00 per cent manganese. The pearlitic manganese has considerably less carbon and more manganese, together with very small amounts of sulphur and phosphorus. The common disks used are not heat-treated.

[1]Research specialist in agricultural engineering, University of California. Mem. A.S.A.E.

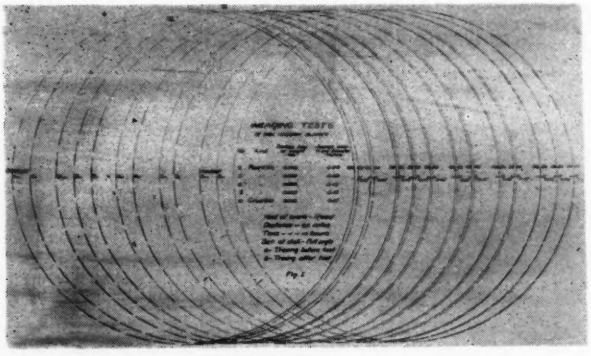


Fig. 1. The edges of the disks were traced before and after the test

Those of pearlitic manganese were heat-treated to secure four different degrees of hardness. The Brinell hardness numbers of those tested were 207 to 235 for the common and 444, 418, 418, and 387 for the pearlitic manganese disks.

Before the beginning of each test each disk was weighed and its outline traced, Fig. 1. The disks were then placed on a 12-disk harrow, as in Fig. 2, and used at full angle of set for a distance of about 35 mi. Most of the work was along a graveled road which put a very severe test on the disks. There was no chipping or breakage in any of the edges, but considerable edge deformation occurred in the common crucible steel and a little in the softest of the pearlitic manganese disks. The hardest disks maintained a sharp cutting edge throughout the test. The amount of wear is shown in Fig. 1. It averaged about four and one-half times as much in the common disks as in the hardest of the pearlitic manganese. A second test verified the results of the first.

The cost of better material and the heat-treatment is not prohibitive, and several prominent manufacturers are already marketing heat-treated disks at no increase in price to the farmer.

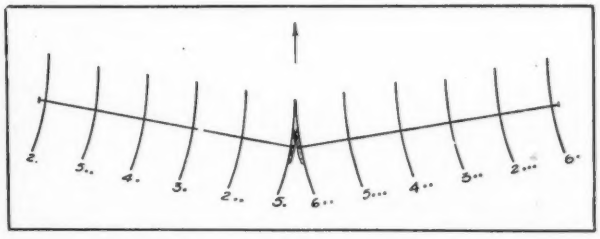


Fig. 2. How the disks were placed. Disks numbered "6" are common crucible steel; those numbered "2" are the hardest pearlitic manganese. The arrow indicates direction of motion

The Rotary Hoe*

By R. I. Shawl[1]

THE rotary hoe is fast becoming a necessary piece of machinery on many corn belt farms. It was invented by a farmer, William L. Niemann, at Mt. Olive, Ill,, in 1890. It was designed to break up the soil crust, stir the soil close to the young plants, allow air and light to warm the soil, and to destroy the young weeds just starting to take root. The principal use of the hoe has been in corn and soybeans, but it is being used successfully in mint, cotton, potatoes, and on wheat and oats fields in the spring.

In operation the transport or supporting wheels are lifted clear of the ground in most cases, and the weight carried on the hoe wheels. In cases where the soil is very hard and difficult to penetrate, considerable weight is put on top of the hoe. The depth of penetration of the wheel fingers varies from 1 to 3 in. depending on soil conditions. The machine is driven over the rows or field without regard to the location of the young plants. This means that a boy can do a man's work in the field with this tool. The hoe can be used in corn until it is 7 to 9 in. high. One case came to our attention where the hoe was used until the corn was about 18 in. high.

A manager of 15,000 acres of land in Illinois and Missouri stated that he used the rotary hoe on most of his land and considers it a first-class implement. He has had no trouble with the hoe working in his soil types. He also states that he hoed the ground twice, broadcasted sweet clover and then followed with a rotary hoe and corrugated roller.

Will Riegel, who is farming 1,000 acres of land south of Urbana, Ill., uses the hoe exclusively on his 250 to 350 acres of soybeans, and on a like acreage of corn for the first cultivation. He says that he could not farm without the rotary hoe.

The rotary hoe was used by the department of farm mechanics of the University of Illinois on 80 acres of corn in 1926. Three 7-ft. hoes were hitched back of a tractor, and the young corn which was not large enough to plow was given two cultivations with this outfit, about a week apart. It took 9½ hr. the first time over and 9 hr. the second time over to cover the 80 acres of corn.

The agronomy, dairy and animal husbandry departments at the University of Illinois use the rotary hoe for cultivating corn during the first few cultivations and also on soybeans when they are grown.

The rotary hoe probably finds its greatest use in the corn belt states. It has been found that the hoe does not work satisfactorily under all soil conditions. Where the ground has become extremely hard, it is often impossible to secure penetration even though considerable weight is placed on the machine. If weeds have firmly anchored themselves in the soil, the hoe will not successfully destroy them. Sandy or very loose soil is not benefited much by the use of the hoe and in some cases young seedlings may be dislodged. Pea and morning glory vines tend to wrap up in the hoe, and small rocks in the soil may cause breaking of the hoe wheel fingers.

Several sizes of the rotary hoe are being manufactured: The small, one-horse machine, the 7-ft. machine drawn by two horses, and the 9 and 11-ft. machines drawn by four or five horses. The 7-ft. machine seems to be the most popular type because it will work best on uneven ground. The 9 and 11-ft. machines, being of rigid frame construction, do the best work when the ground is quite level. Some hoes are being put out with tongue trucks in front, with a transport wheel at each end; while others have two wheels ahead and two wheels back of the frame to support the weight of the machine, but no end wheels. Some hoes have a one-piece axle extending the length of the machine, and the rotary wheels mounted on the axle so as to turn independently of each other. Another type of hoe has several short axles to which are rigidly attached several of the hoe wheels so they all have to turn together. One manufacturer has produced in an experimental way a set of three rotary hoe wheels mounted in a frame with standards so that the two front shovels next to the row and their standards can be removed from their tractor cultivator and the rotary hoe attachment added This rotary hoe attachment will cultivate the corn row and the regular cultivator shovels will cultivate the middles.

The present season of 1927 has been an excellent one for the use of the rotary hoe. Fields of corn that stood for some time after planting became green with small weeds, and the corn was not large enough to cultivate by the ordinary method, but by the use of rotary hoes farmers have been able to put their fields in first-class condition. The demand for rotary hoes this season has far exceeded the number of hoes that the manufacturers planned to build. In some cases companies have had to put through rush orders for a considerable number of extra machines.

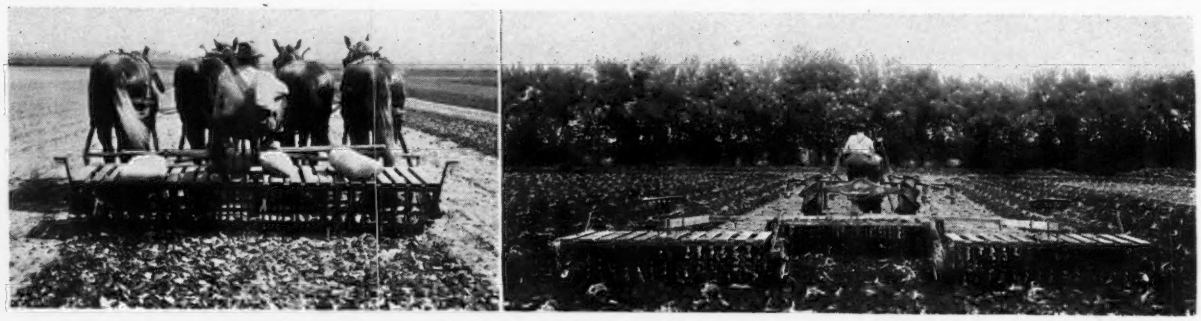
The rotary hoe, I believe, is here to stay, and it only requires time for farmers to discover what this tool can do for them.

*Paper presented at the 21st annual meeting of the American Society of Agricultural Engineers at St. Paul, Minn., June, 1927. Contributed by the Power and Machinery Division.

[1]Assistant professor of farm mechanics, University of Illinois. Assoc. Mem. A.S.A.E.

Spray Irrigation in the Eastern States

THE eastern states are subject to droughts of more or less severity which damage all growing crops, but especially such truck crops as lettuce, strawberries and potatoes which are materially injured by short periods without rain. To safeguard these crops from drought it is often feasible to install irrigation systems to provide a water supply to supplement the rainfall. The most common method of applying water to crops in the humid region is known as spray irrigation.



Two views of rotary hoes at work showing character of the work performed

Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture

The Moisture of the Podsol in Freezing and Thawing in the Year 1923-24, F. V. Chirikov and A. Maliugin, (Nauch. Agron. Zhur. (Jour. Landw. Wiss.), 3 (1926), No. 1, pp. 40-51, figs. 3; Eng. abs., p. 50).—Studies conducted at the Agricultural Institute at Kazan, the purpose of which was to explain the process of the movement of water in soil in the fall and in the spring are reported. The observations of soil moisture in the field in the fall were made on plowed and unplowed soils. A movement of water from lower strata to higher strata was observed during the freezing of the soil. This was distinctly evident both on plowed and unplowed soils in the fall. A dry stratum occurred under the moist surface strata. The movement of water from one stratum to another during freezing of soil was found to proceed in the form of a vapor. Moisture movement took place more energetically in plowed than in unplowed soil. A stubble soil held snow better than a soil plowed in the fall. There was a relatively greater drying of the surface soil of a plowed field during freezing. During thawing condensed and snow water accumulated in the surface soils was pressed out, so that fall plowing was without result in moisture accumulation.

The Movement of Soil Moisture in the Vapor Phase, Parts I, II (Abstracts in Journal, American Society of Agronomy, 17 (1925), No. 10, pp. 642, 643).—This is an abstract of two papers presented at the ninth annual meeting of the American Society of Agronomy at Fort Collins, Colo., June 18-20, 1925. The first, by J. C. Russel, deals with some theoretical considerations, and the second, by H. E. Weakley, with experimental observations.

Laboratory and field data, from studies conducted at the Nebraska Experiment Station, were presented to show the magnitude and importance of vapor movements. The evaporation of water from a free water surface into the atmosphere directly or through dry porous material, either soil or sand, was shown to be a linear function of saturation deficit. The rate of evaporation varied with the porosity of the material, but was not affected by its hygroscopicity. As much water passed from a free water surface through dry coarse sand as through dry, coarse granular soil of identical permeability coefficient. The size rather than the quantity of pore space determined the extent of the water lost. Cracks in a soil mass seemed to allow very rapid vapor movement.

The evaporation of water from a wet mass of soil when not more moist than the field carrying capactiy seemed to follow all of the laws of vapor movement. As much water was lost from wet soil columns when they were broken by air gaps as when they were continuous.

Investigations into the Resistance of Sandy Soils to Wetting, R. Albert and M. Kohn (International Review of Science and Practice Engineering [Rome], n. ser., 4 (1926), No. 2, pp. 312-318).—Studies conducted at the Soil Science Institute of the Eberswalde Forestry High School are briefly reported which indicate that the vegetable humus coverings of the grains of soil clay, at least in many cases, a decisive part in the saturability of the soil concerned.

The Relation of Light to Soil Moisture Phenomena, L. B. Linford (Soil Science, 22 (1926), No. 3, pp. 233-252, figs. 6).—Studies conducted at the Utah Experiment Station showed that soils at the moisture content corresponding to the hygroscopic coefficient will continue to absorb large amounts of water when exposed to a saturated atmosphere in a dark constant temperature chamber. The amount that the soil will absorb is in excess of the moisture content at the wilting coefficient. The equilibrium point reached under any but isothermal conditions was found to be a function of the light intensity in the apparatus containing the soil. Laboratory light was sufficiently intense to cause serious differences in temperature between transparent and dark bodies.

A theoretical discussion of the problem is also presented.

Maximum Height of Capillary Rise Starting With Soil at Capillary Saturation, C. F. Shaw and A. Smith (Hilgardia [California Station], 2 (1927), No. 11, pp. 399-409, figs. 2).—In experiments conducted at Berkeley and Davis, the rise of water to the surface through Yolo sandy loam and Yolo loam when wetted by rains or irrigation was found to be fairly rapid when the water table stood at 4 ft. below the surface, was slower with the water table at 6 ft. below the surface, and was comparatively slight with the water table at 8 ft. The 8-ft. depth appears to be close to the limit for such capillary rise, practically no water being lost from the soil when the water table was at 10 ft. below the surface. The experiments are regarded as suggesting that, for sandy loams and loams in general, water tables at 10 ft. or more below the surface would be below the maximum height of capillary rise and would result in no movement of water to the surface.

Some Effects of Mulching Paper on Hawaiin Soils, G. R. Stewart, E. C. Thomas, and J. Horner (Soil Science, 22 (1926), No. 1, pp. 35-59, figs. 6).—Studies conducted at the experiment station of the Hawaiian Sugar Planters' Association are reported which showed that paper mulch exerts several effects upon Hawaiian soils planted to pineapples. Chief among these effects are a higher soil temperature, a higher content of soil moisture, and a more rapid elaboration of soil nutrients. The temperature effect of the paper mulch varied with the weather and with the season of the year, and it is thought probable that it will also vary with the degree of shading of the mulching paper by the pineapple plants.

The greatest increase in soil temperature due to mulching paper occurred in clear bright weather. Rain decreased the temperature differences between the mulched and the bare soil. In heavy rains the temperature differences disappeared, and for short periods the bare soil appeared to be slightly warmer. The maximum soil temperature occurred at from 2 to 4 p.m., about two hours after the maximum air temperature. The greatest differences between mulched and bare soils occurred during the warmest months of the year.

There was an appreciable effect of the paper mulch upon the retention of moisture in field soils, the mulched soils having a noticeably higher moisture content than the bare soils. A consistently higher nitrate content was found in paper mulched soils which had received no fertilizer, as well as in those receiving ammonium sulfate and a complete fertilizer mixture. This is taken to indicate that the paper mulch probably causes a more rapid elaboration of the principal soil nutrients.

Annotated Bibliography on the Storage of Cottonseed and of Seed Cotton, H. M. Steece (U. S. Department of Agriculture, Extension Service, Official Cooperating Extension Work, 1926, pp. 13).—This mimeographed bibliography presents in summary form the results of official and other investigations concerned with the storage of cottonseed and seed cotton, and calls attention to bulletins and articles giving general information on the problem.

Cool Storage Investigations, Season 1925, N. McClelland and L. W. Tiller (Cawthron Institute, Nelson, N. Z., Chemistry Department Bulletin 1, n. ser. (1926), pp. 16, pls. 3).—A brief report upon apple storage investigations conducted by the Cawthron Institute, New Zealand. Considerably more flesh collapse occurred in fruits stored at 32-34 deg. F., with a humidity of 50 per cent, than in those held at higher temperatures and higher humidities. Since collapse was even more prevalent in a lot stored at 32-34 deg. F. with high humidity, the author believes that temperature is the chief causal agent. This flesh collapse is considered identical with internal breakdown of other countries, and may be practically eliminated by storage at 46 deg. F. The location of the orchard in which the fruit was grown affected its keeping. Varietal differences also played a role, Delicious, for example, storing better at low temperatures and high humidity than many other varieties. Although it is not conceded practical to maintain the temperature high enough to avoid this internal injury, it is believed that a temperature of 38-40 deg. F. combined with a reasonably low humidity will hold the loss at a minimum.

Investigations in Cool Storage, C. E. Baker (Indiana Horticultural Society Transactions, 1925, pp. 58-71).—Studies by the Indiana Experiment Station in an air-cooled storage cellar showed that natural air cooling is not sufficeint to keep Grimes and Jonathan apples from rapid ripening. The addition of ice during September and October reduced temperatures from 12 to 18 deg. F. below that of a comparable uniced chamber, and the fruit in the iced chamber kept considerably longer. However, as the temperature of the iced compartment averaged approximately 56 deg. F. during September, whereas the ideal temperature for apples is 31 to 32 deg. F., the author considers icing to be impractical from the commercial viewpoint. In concluding, the author points out the necessity of careful ventilation and the advisability of introducing fruit into the storage cellar in the early morning. The use of shredded oiled papers as a medium for preventing scald in Grimes and York Imperial is discussed.

Cool Storage of Washington Navel Oranges, J. E. Harrison (Journal, Department of Agriculture Victoria, 23 (1925), No. 7, pp. 428-432).—The year's experimentation emphasizes the points that fruits from different districts differ as regards keeping quality, that sweating best minimizes mold outbreak in cool storage of Washington Navel oranges, that an average temperature of 32 deg. F. causes danger of freezing, and that 34 deg. F. is the most satisfactory storage temperature.

Experiments in Cool Storage of Apples, D. B. Adam and J. E. Harrison (Journal, Department of Agriculture Victoria, 23 (1925), No. 4, pp. 226-234).—This is a further report upon the results of cold storage investigations with fruit in Victoria, Australia.

Records taken in 1923 on early picked, unwrapped Jonathon apples stored in direct expansion chambers at 32 and 37 deg. F. showed much less scald development at the higher temperature, the percentages of sound fruits being 15+ and 77+ per cent, respectively. On the other hand, in the case of riper fruits prac-

tically no scald developed at either temperature, whether or not the apples were wrapped in oil paper. Similar investigations conducted in 1924 with Jonathan and Rome apples bore out the value of the higher temperatures in reducing scald in the Jonathan variety. Conflicting results obtained with oiled and plain paper wrappers prevented the drawing of definite conclusions, although in several instances the oiled wrappers were apparently the more effective. Jonathans pickd April 7, 1924, and stored in direct expansion chambers at 32, 34, and 37 deg. F. showed on June 25, 56, 55, and 97 per cent of sound fruits, respectively. On the other hand, in Rome apples, scald apparently developed more readily at 37 than at 32 deg. F. leading the authors to suggest that scald in the two varieties may be due to different causes. Observations on lots of Jonathan and Rome harvested at different stages gave further evidence that in these varieties mature fruits are the least susceptible to scald.

Electroculture Investigations (Journal, Ministry of Agriculture [Great Britain], 33 (1926), No. 2, pp. 102-104).—Further pot experiments at Rothamsted showed the consistent effect of electrification in increasing the grain yield of barley even in the absence of increased vegatative growth. Only small differences were observed between electrified and control plats with barley at Rothamsted and oats at Lincluden near Dumfries. A careful physiological study indicated that electrification of the plant led to fewer sterile flowers, less shriveled grains, and increased weight of grain.

Spray Irrigation in the Eastern States, G. A. Mitchell and F. E. Staebner (U. S. Department of Agriculture, Farmers' Bulletin 1529 (1927), pp. II + 27, figs. 8).—Practical information on the subject is given which relates particularly to systems of small or only moderate size, suitable for home gardens and fields up to four or five acres.

Irrigation in India (India Department of Industry and Labor, Public Works Branch, Irrigation India Review 1924-25, pp. 37).—The progress of irrigation in the various provinces of India during the year 1924-25 is presented in detail.

Cold Storage for Iowa Apples (Iowa Station Report 1926, pp. 46, 47).—In cooperation with the chemistry section of the station a comprehensive study was made on the acidity of apples under cold storage conditions to determine whether there was a correlation between the rate of loss of acidity and the development of such storage troubles as scald, breakdown, and Jonathan spot. It was found that fruit stored at temperatures of from 30 to 32 deg. F. is more apt to breakdown and soft scald than fruit stored at slightly higher temperatures. An investigation of the cold storage trouble known as Jonathan spot showed that the black spots are caused by a color change in the pigment around the lenticels. H-ion determinations indicate that the spotted areas are less acid than the normal skin, which has a clear red color. By treating spotted apples with fumes of hydrochloric acid, the original color is restored. In experiments in which impregnated wraps were used the percentage of Jonathan spot was reduced from 44 to 7 per cent.

The Movement of Moisture with Reference to Timber Seasoning, S. T. C. Stillwell ([Great Britain] Department of Science and Industrial Research, Forest Production Research, Technical Paper 1 (1926), pp. IV + 29, figs. 10).—Studies are reported the purpose of which was to ascertain what actually occurs in timber during the process of evaporation insofar as moisture movements are concerned, and the results are presented in terms of rather complex mathematical expressions. There is nothing in the results which is directly antagonistic to the idea of a dual flow of the general form of flow equation.

The Manufacture and Use of Small Dimension Lumber, R. J. Hoyle (New York State College of Forestry, Syracuse University, Technical Publication 20 (1927), pp. 94, figs. 25).—This publication is written with the idea of encouraging the manufacture of small dimension lumber. It emphasizes the difficulties and problems of manufacture and devotes considerable space to the consumption of small dimension.

Mechanical Properties of Dutch East Indian Timbers, L. G. Den Berger (Department Landb???1?? Nijv. en Handel Nederland. Indie, Meded. Proefsta. Boschw., 12 (1926), pp. VIII + 63, figs. 2).—The results of a large number of tests of the mechanical properties of Dutch East Indian timbers are tabulated and briefly discussed. The results indicate that a relation exists between most of these properties and the specific gravity, an increasing specific gravity being in general accompanied by higher values with a few exceptions.

Some Commercial Softwoods of British Columbia, T. A. McElhanney and R. S. Perry (Canada Department of the Interior, Forest Service Bulletin 78 (1927), pp. 45, figs. 22).—The purpose of this bulletin is to provide reliable data on some of the principal commercial timbers of British Columbia, with particular reference to their mechanical and physical properties. The results of a number of tests of different woods are tabulated.

Primary Stresses in Timber Roofs, with Special Reference to Curved Bracing Members, A. J. S. Pippard and W. H. Glanville ([Great Britain] Department of Science and Industrial Research, Building Research, Technical Paper 2 (1926), pp. IV + 32, pl. 1, figs. 11).—A theoretical analysis of intricate timber roofs is presented and the method applied to a simple hammer beam roof, a timber roof with steel ties, and a small arched hammer beam roof.

A Study of Hard Finish Gypsum Plasters, T. N. McVay (Illinois University Engineering Experiment Station Bulletin 163 (1927), pp. 46, figs. 14).—Studies of the physical properties of hard-finish gypsum plasters and an investigation of the mechanism of setting are reported.

The results indicate the probability that plasters having a high strength may be produced at a relatively low cost in commercial practice. The greater strength of plasters calcined at high temperatures, as compared with those calcined at low temperatures, appears to be due to the more thorough crystallization of the former and also to the smaller amount of mixing water used, which produces plasters of greater hardness and density.

Plasters of widely varying physical properties can be produced by treating gypsum with soluble sulfates before or after the final calcination. The former method causes the plasters to be more plastic but at the same time to have higher shrinkage. Potash alum seems to produce more satisfactory results than Glauber's salt. The physical properties of the plaster can also be controlled to a considerable degree by the temperature of calcination, assuming that the concentration of the soluble sulfates remains fixed. The higher the temperature of calcination the slower are the reactions that take place in setting.

New Sand Test, C. M. Chapman (Concrete [Chicago], Cement Mill Ed., 31 (1927), No. 3, pp. 16, figs. 2).—A new rapid field method is described and illustrated for determining the moisture, voids, and specific gravity of sand for use in concrete.

An Investigation of Web Stresses in Reinforced Concrete Beams, F. E. Richart (Illinois University Engineering Experiment Station Bulletin 166 (1927), pp. 106, figs. 34).—The results of tests over a period of twelve years of reinforced concrete beams are presented and discussed. The tests were all made on simple beams subjected to two-point loading, so that in all cases the web reinforcement was kept in a region of constant shear.

All beams without web reinforcement failed by diagonal tension at shearing unit stresses, varying from 130 to 250 lbs. per square inch with one exception. The beams without web reinforcement all failed quite suddenly, and lacked the desirable characteristics of toughness and ability to yield gradually at failure which were found in those having web steel.

Relatively large diagonal tension stresses were developed when the shearing stress was large in comparison with the flexural stress. This condition was found in short, deep beams and in beams having high amounts of longitudinal reinforcement. It appeared that higher allowable values of shearing unit stress may be used in reinforced concrete beams than are now common, provided sufficient web reinforcement is used to satisfy the design formula and care is taken to guard against other forms of failure.

A somewhat systematic variation, evidently dependent upon the manner of loading, was found in the measured stresses in the web reinforcement at points along the length of the beams. Low stresses were found near the load point and the support, while the maximum stresses were generally found in the middle portion of the region between. The largest number of diagonal cracks generally formed in this middle portion.

A variation in stress was also observed along the length of web members. Except in a few cases in which the stirrup was near the load point, this stress was greatest near the bottom of the web member, decreasing toward the upper end. The position of maximum stress clearly depended upon the intersection of the web member with the main diagonal cracks. Only on the most highly stressed gauge lines did the observed stresses in web members approach the calculated stresses. The ratio between measured and calculated tensile stress in web members increased as the percentage of web reinforcement increased.

The results of the tests agreed fairly well with the theory in indicating approximately equal effectiveness of vertical web members and members inclined at 45 deg. to the horizontal. The difference in effectiveness observed seemed to be in favor of the vertical stirrup.

Steel Construction, H. J. Burt (Chicago: American Technical Society, 1927, pp. 396, figs. [246]).—This is a text and reference book covering the design of steel framework for buildings. It contains sections on method of manufacture, steel sections—adaptability and use, quality of material, unit stresses, rivets and bolts, beams, riveted girders, compression members—columns, tension members, wind bracing, practical design—a sixteen-story fireproof hotel, protection of steel, and specifications.

Tests of the Fatigue Strength of Cast Iron, H. F. Moore, S. W. Lyon, and N. P. Inglis (Illinois University Engineering Experiment Station Bulletin 164 (1927), pp. 50, pls. 9, figs. 23).—Studies are reported, the results of which are considered to be a contribution to the knowledge of the strength of cast iron as a material of construction.

For the cast irons tested the endurance ratios varied from 0.33 to 0.46, with an average value of 0.35. This average value may be compared with average values of 0.5 for wrought iron and steel and 0.42 for steel castings. Specimens from a large cylinder casting showed lower values for both ultimate tensile strength and for endurance limit than did specimens from castings in the shape of pipes. The endurance limit of the latter specimens was increased about 30 per cent, and that of the former about 40 per cent by the application of a large number of cycles of stress slightly below the original endurance limit. This is taken to indicate that cast iron develops some intra-crystalline slip with consequent favorable readjustment of stress distribution without starting a fatigue crack.

The effect of holes and grooves in reducing the fatigue strength of specimens from castings in the shape of pipes was found to be less than these effects in steel specimens, and much less than the effect indicated by the theoretical stress intensification at such irregularities.

Tests at elevated temperatures of specimens from castings in the shape of pipes gave little indication of reduction of either ultimate tensile strength or of fatigue. Strength up to 800 deg. F. and the proportional diminution of fatigue strength under higher temperatures was found to be slightly less than the proportional diminution of ultimate tensile strength and of Brinell hardness.

Tests of the fatigue strength of these specimens under cycles of flexural stress varying from 0 to a maximum in tension showed the endurance limit to be 48 per cent above the endurance limit for cycles of completely reversed stress. Tests of the fatigue strength under cycles of axial stress varying from 0 to a maximum in compression showed the endurance limit to be 59 per cent of the ultimate (static) compressive strength.

House and Home, G. Gray (Philadelphia and London: J. B. Lippincott Co., 1927, 2 ed., rev., pp. XI + 356, pl. 1, figs. 189).—This is intended to be a manual and textbook of practical house planning. It contains chapters on the home and the house; the location; plans; house planning; materials and construction; plumbing; heating; lighting; built-in conveniences and labor savers; exterior design—ancient and medieval architecture; exterior design—modern architecture; interior design; the grounds; the business of building; alterations; the farm house; multiple houses and the housing problem; the standard house; reducing the cost of shelter; town planning; owning versus renting; and suggestions to teachers. A bibliography is included.

Your House, J. R. McMahon (New York: Minton, Blach & Co., 1927, pp. IX + 307, pls. 4, figs. 21).—This is a very popular treatise on the financing, planning, building, remodeling, and upkeep of a home.

Poultry Housing, O. M. Wilbur (Maine Agricultural College Extension Bulletin 173 (1927), pp. 16, figs. 20).—Practical information on the planning and construction of poultry houses for Maine conditions is presented, together with working drawings and bills of material for typical structures.

Machine Sheds, H. B. White and M. G. Jacobson (Minnesota University Agricultural Extension Special Bulletin 115 (1927), pp. 12, figs. 9).—Practical information is given on the planning and construction of machine sheds, together with working drawings of typical structures.

Silos and Silage, R. W. Thornton Et Al. (Union So. Africa Department Agricultural Bulletin 7 (1927), pp. 46, figs. 24).—Practical information on the planning and construction of different types of silos is presented, together with working drawings and bills of materials, and discussions on the making and feeding of silage are given.

Pit and Trench Silos, H. L. Patty (South Dakota Agricultural College Extension Circular 264 (1927), pp. 15, figs. 8).—Practical information is given on the planning and construction of pit and trench silos adapted to South Dakota conditions, together with working drawings for typical structures.

Constructing a Wooden-hoop Silo, A. B. Crane and W. W. Henry (Washington State College Extension Bulletin 141 (1926), pp. 16, figs. 13).—Practical information on the construction of a wooden hoop silo is given.

The Construction of Smokehouses for Small Rubber Estates, T. E. H. O'Brien (Ceylon Department of Agriculture Bulletin 79 (1926), pp. [1] + 7, pls. 4).—The general principles of smokehouse design for rubber curing are presented and working drawings for typical structures are given.

The primary purpose of smoke curing of rubber is to dry the sheets, and efficient ventilation should be provided in order to carry away the moisture as quickly as possible. Each wet sheet placed in a smokehouse contains approximately 0.5 lb. of water which requires at least 65 cu. ft. of dry air at a temperature of 115 deg. F. for its removal. In a smokehouse containing 3,000 sheets, a minimum flow of air of 20,000 cu. ft. per day is required if the sheets are to be dried in ten days. There should be ventilation both at the top and bottom of the smokehouse, and either the top or bottom ventilators should be capable of adjustment. The object should be to obtain a uniform draft throughout the smokehouse.

Since another object of smoking is to render the sheet resistant to mold, it was found by experiment that sheet smoked with uncombusted smoke is more resistant to mold than sheet smoked with combusted smoke. In general an open fire at floor levels tends to give combusted smoke, whereas a fire in a deep hole in the floor gives a higher proportion of uncombusted smoke.

A Thresher for the Plant Breeder and the Cereal Chemist, W. O. Whitcomb (Journal American Society of Agronomy, 19 (1927), No. 4, pp. 265-270, figs. 5).—In a contribution from the Montana Experiment Station a thresher for use by the plant breeder and cereal chemist is described and illustrated, which has no toothed concave and in which the cylinder is mounted directly on the motor shaft. The power required to operate both the thresher and the fanning mill can be supplied by a ¼ h.p. electric motor, with a speed of 1,150 r.p.m. The best speed for the cylinder was found to be from 1,200 to 1,400 r.p.m. The removal of the grain drawer for each plant or other unit prevents the mixing of the grain. It was found that two men working with the thresher and fanning mill combined can thresh from four to six plants per minute.

The Farm Water Supply and Sewage Disposal (Ontario Department of Agriculture Bulletin 330 (1927), pp. 83, figs. 66).—A large amount of information is presented on the mechanics and chemistry of farm water supply and sewage disposal systems, with particular reference to conditions encountered in the Province of Ontario.

Solving Sewage Problems, G. W. Fuller and J. R. McClintock (New York and London: McGraw-Hill Book Co., 1926, pp. X + 548, pl. 1, figs. 83).—A concise presentation is given of the fundamental principles of sewage purification and disposal. Sufficient details as to the arrangement of new plants are given to indicate recent advances in the art. Chapters are included on outline of problems; legal and legislative aspects; administrative aspects; characteristics of sewage; basic design data—rational methods; biochemistry of sewage; limitations of dilution method—nuisance aspects; hygienic aspects; natural purification of streams; oxygen balance—residual oxygen; plankton—biological balance; lakes, oceans, and tidal estuaries; procedures for overcoming limitations of dilution method; collecting system factors; grit chambers; screens; skimming tanks; plain sedimentation; plain sedimentation tanks; disposal of undigested sludge; septicization and gasification; single story septic tanks; two-story septic tanks; separate sludge digestion; gas collection and utilization; disposal of digested sludge; chemical precipitation; electrolytic methods—direct oxidation; chlorination; broad irrigation; fishponds; subsurface irrigation; intermittent sand filters; contact filters; trickling filters; final settling tanks; activated sludge process; activated sludge plants; disposal of activated sludge; activated sludge as fertilizer; and a nontechnical summary.

Book Review

"Mathematics for Agriculture and Elementary Science" is a new book by H. B. Roe, associate professor of agricultural engineering, University of Minnesota; G. E. Smith, professor emeritus of mathematics, Teachers College, Columbia University, and W. D. Reeve, professor of mathematics, Teachers College, Columbia University. The purpose of this book as set forth in the preface is to supply the practical mathematics needed in elementary courses in the sciences, with particular emphasis upon the needs of students of agriculture and forestry. Although written primarily to meet the needs of freshmen students in colleges of agriculture and other institutions of collegiate grade offering a brief course in general mathematics as a preliminary to other courses, it should also be found useful in the upper classes in high schools or in junior colleges where it is desired to give an insight into the utilitarian aspects of the mathematics lying beyond the range covered by the ordinary high school course.

The book presupposes the amount of algebra and plain geometry usually studied in the high school, but it recognizes the fact that students often forget the technique of these two subjects, particularly algebra. The book, therefore, begins with a brief review of algebraic operations, linear and quadratic equations, and graphs, with the work strictly limited to those phases that will be needed in subsequent chapters. The necessary facts of geometry are reviewed from time to time as they are required in the development of the subject.

In the application of the various mathematical processes the needs of the general student as well as those of the students of agriculture have been carefully considered, so that by the simple expedient of omiting topics not vital under local conditions, the book can be adapted to various types of courses. As this is essentially a textbook on mathematics, no attempt has been made to cover such fields as mechanical drawing, surveying, physics, and the like. Supported by explanatory notes and illustrated examples, however, it draws freely upon these fields for problems which show the practical application of mathematics and which stimulate the student's interest.

At the end of the book is a list of useful tables which though inserted primarily as aids in computations in connection with work of the various chapters, are helpful in general computations and in increasing the value of the book as a source of practical problem material and general information.

The book contains the following chapter headings: Review of algebraic functions, review of equations, graphs and functions, logarithms, elementary series, statistics and averages, investments, dairy problems, farm management, variations, numerical trigonometry, practical mensuration, and formulas in agricultural engineering.

The book is published by Ginn & Company, New York, N. Y. The list price is $2.80.

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RAYMOND OLNEY, Editor

Research at "Low Flow"

THE much discussed and more misunderstood subject of research in the application of engineering principles to agricultural practices is one of our troubious responsibilities which insistently demands the spotlight at quite regular intervals. Since it happens to be the oasis around which our profession, thirsting for facts, continues to crowd, it is a matter which cannot be permanently disregarded, no matter how hard we try.

Unfortunately even an oasis will dry up under certain circumstances, especially one supplying the facts which permits a profession to live. When the well of facts is overflowing, due to the painstaking efforts of some farseeing and self-sacrificing members of the profession, others are likely to consider the life-giving waters of knowledge as coming from an inexhaustible source which needs no further attention. This misconception breeds superficiality of thought and endeavor, and sometimes results in overambitious excursions into unknown desert fields, where, due to inattention and mistreatment, the oasis of knowledge pinch out and leave the inadequately equipped traveler gasping for assistance.

A situation has developed in this connection which should be of considerable concern to the members of this Society. A critical examination of the research in agricultural engineering during the past fiscal year indicated that a period of "low flow" in the waters of research knowledge in our profession was approached. Apparently the low point was not reached during the year so that conditions appear to be still on the down grade. This means in plain words that the amount of sound and creditable research in the subject was approaching a very low ebb and had not yet reached the low point. As always occurs at such times, these conditions were masked to a considerable degree by a great deal of sincere but, nevertheless, superficial endeavor largely without definite purpose and direction, simply riding to the bare sands on a wave of previous prosperity in thought and knowledge.

Numerous reasons have been advanced in explanation of this situation. The old excuse that funds are not available or cannot be secured for research in agricultural engineering is now obviously a mighty weak and out of date justification for inactivity. Anyone who has had personal contact with college deans and directors of agricultural experiment stations over the country knows that they will support sound, productive research so far as their total finances will permit.

The fact that the records show, in general, more funds allotted to research in other agricultural subjects than to agricultural engineering does not mean in any case that agricultural engineering is being discriminated against. It simply means that we agricultural engineers have failed to approach the experiment station directors with as sound and creditable research programs as have the other agricultural divisions of the experiment stations. The director cannot be an expert in all subjects and must therefore act on the best knowledge and advice available. He cannot do more than look askance on any broad, general, superficial proposition without definite purpose or direction.

The argument that agricultural engineering was discriminated against in the Purnell Bill is and always has been without foundation. If anything, agricultural engineering is specifically favored by the wording of the bill. It is true that agricultural economics and sociology and home economics were specifically mentioned in the law as subjects for which it is permissable to use the fund. This was obviously and wisely done to prevent their exclusion.

It is also true, however, that the first section of the law contains the following sentence: "The funds appropriated pursuant to this act shall be applied only to paying the necessary expenses of conducting investigations or making experiments bearing directly on the production, manufacture, preparation, use, distribution, and marketing of agricultural products and including such scientific researches as have for their purpose the establishment and maintenance of a permanent and efficient agricultural industry." In what plainer terms than the words "production" and "manufacture" can agricultural engineering be implied? The production and manufacture of agricultural products present the main justification for the existence of agricultural engineering as a part of an agricultural research institution.

The fact that during the fiscal year 1926-27 agricultural economics and sociology received in round figures 38 per cent of the Purnell fund, home economics 13 per cent, and agricultural engineering only 3 per cent would therefore seem to indicate that workers in the first two subjects read the bill, recognized their responsibilities in that connection, and acted accordingly, while the agricultural engineers, with a few outstanding exceptions, either did not read the bill or did not recognize their responsibilities and act accordingly if they did read it.

The Hatch, Adams, and Purnell Acts, the three acts creating and endowing the state agricultural experiment stations, all speak of the "agricultural industry" instead of simply "agriculture." This evidently implies that agricultural engineering should be a recognized and important part of the program of every agricultural experiment station, regardless of whether the financial support comes from any of these funds or from the state.

The observed fact that research in agricultural engineering has been slipping badly during the past year or so therefore does not sound well for our profession. This cannot occur too often and our profession maintain its dignity and integrity. It is professional suicide for us to establish a foundation and then, through inactivity resulting from overconfidence and egotism, to let that foundation become inadequate. Someone, not an engineer, has said, "Egotism is the anaesthetic nature gives to deaden the pain of being a fool."

This warning is therefore sounded without evasion or reservation. Let us quit making excuses for our research inadequacy and climb back into the foundation pits of our profession and dig. Unusual efforts have been made by this Society and another national association together with the federal government to aid in the organization of sounder and more creditable research in mechanical farm equipment. A similar movement is being started in farm structures. All of the professional divisions of this Society are, in fact, interested in promoting more and better research. The Research Committee stands ready to critically scrutinize any research proposal. With these facilities available there should never be an ebb tide in our research output.

RESEARCH COMMITTEE

A. S. A. E. and Related Activities

Pacific Coast Section Meeting

TILLAGE and tillage machinery were given the undivided attention of members and guests of the Pacific Coast Section of the Society when it met in the new agricultural engineering building at University Farm, Davis, California, January 13. The San Francisco Tractor and Implement Club held its January meeting at University Farm on the same date and cooperated with the Section in putting on its program.

W. W. McLaughlin, chairman of the Section, opened the meeting, introducing Dr. W. L. Howard, director of the Davis branch of the College of Agriculture, University of California, who welcomed the group to Davis and the university farm.

"The Farmer's Problem in Grain Farming Tillage," by T. A Kilkenny, a California grain farmer, was the first paper on the technical program. The next paper, "Row Crop Tillage," was presented by George Wilson, president of the Yolo County Farm Bureau.

James Mills, Jr., manager of the Mills Orchard Company, presented "Operation and Cost Accounting of Tillage Machinery," the last paper on the morning program.

Following luncheon the San Francisco Tractor and Implement Club and the Pacific Coast Section of the A.S.A.E. each held a short business meeting. In the afternoon more technical papers were read, the first being "Tillage from the Standpoint of Soils," by Charles F. Shaw, professor of soil technology, University of California.

A paper, entitled "The Plow as a Tillage Tool," was presented by W. G. Criswell, International Harvester Company, and "Principles of Deep Tillage," by L. Y. Leonard, county agent, Sacramento County.

John Q. McDonald of the Caterpillar Tractor Company talked on "Tillage Machinery Recently Introduced in the West." This was the last talk on the program. Each of the technical papers were briefly discussed immediately following the presentation.

The final event was an inspection and demonstration of tillage machinery. The fact that the date was Friday the thirteenth apparently did not detract from the meeting, as it was well attended and highly successful in every respect.

North Central Section Meeting

ANNOUNCEMENT is made of the preliminary program of the meeting of the North Central Section of the American Society of Agricultural Engineers to be held at Iowa State College, Ames, Iowa, May 18 and 19, 1928. Some of the subjects to be presented at that meeting include the utilization of corn stalks as a by-product, which will be presented by O. R. Sweeney, professor of chemical engineering, Iowa State College. In connection with this subject, E. V. Collins, agricultural engineer, of the same institution, will discuss the subject of harvesting corn stalks for manufacturing purposes. Other subjects to be presented are the combine in the North Central states, rural electrification, and the "L" concrete building block.

Scientists to Continue Fight on Corn Borer

THE fight against the European corn borer will be carried on vigorously in 1928 is the good word which came out of the conference held at the Department of Agriculture, Washington, on January 3. The department's activities will include the cooperation of the states in a comprehensive research and control program, and in an intensive educational campaign in the infested area. Quarantine measures, the cleaning up of river valleys, and other precautions against long distance spread will also be taken up by the government in cooperation with state authorities. The program as outlined by the Department of Agriculture and the states carrying on corn borer research was accepted by the conference.

E. R. Wiggins Passes Away

EDWARD RUGER WIGGINS, manager of sales promotion and advertising, French & Hecht, Davenport, Iowa, passed away at Mercy Hospital, Davenport, on January 31. He was one of the more active members of the American Society of Agricultural Engineers, and at the time of his death was serving as chairman of the Power and Machinery Division. He has served on several important committee appointments and has contributed papers of note before Society meetings.

E. R. Wiggins

Mr. Wiggins was born on a farm near Janesville, Wisconsin, on July 24, 1886, the son of Alexander and Edna Helm Wiggins. He was graduated from the Janesville High School and from the University of Wisconsin, where he received his bachelor's degree in mechanical engineering. In 1912 he received his master's degree in mechanical engineering from the University of Nebraska where, as his thesis work, he conducted one of the first intensive surveys of the use of tractors on farms ever made in this country.

Upon graduation he entered the experimental department of the J. I. Case Threshing Machine Company and was later associated in a similar capacity with the Aultman & Taylor Machinery Company, the Reeves Company, and Deere & Company.

In 1918 he entered the employ of the Chilton Company as western editor of "Chilton Tractor Journal." As a writer on farm machinery for farm and trade publications Mr. Wiggins was nationally known. He was a keen observer, had a very wide knowledge of farm and industrial machinery, and was a fluent writer. So extensive was his experience and knowledge in this field that he was considered one of the foremost authorities on technical matters in the farm implement and road machinery industries.

Mr. Wiggins was married in 1915 to Estella Gamble, of Moline. He is survived by Mrs. Wiggins, a sister and a brother.

In the passing of Mr. Wiggins the agricultural engineering profession and the farm equipment industry lost one of its best friends, and a most loyal and enthusiastic worker.

Personals of A.S.A.E. Members

William Louden, vice-president of the Louden Machinery Company and an honorary member of A.S.A.E., and Mrs. Louden recently celebrated their sixtieth wedding anniversary.

J. K. MacKenzie, assistant to the superintendent, Dominion Experimental Station, Swift Current, Sask., is the author of Pamphlet No. 83 (New Series), entitled "The Combine Reaper-Thresher in Western Canada," just issued by the Dominion of Canada Department of Agriculture at Ottawa.

B. J. Owen, director, Institute of Agricultural Engineering, University of Oxford, England, has recently been appointed consulting engineer to the Royal Agricultural Society, succeeding S. F. Courtney. This position, effective January 1, will in no way affect Dr. Owen's connection with the Institute of Agricultural Engineering at Oxford.

C. E. Ramser, drainage engineer, U. S. Department of Agriculture, presented an illustrated paper, entitled "Results of Experiments in Central Illinois on the Flow of Water in Drainage Ditches for Cleared and Uncleared Conditions of Channel," before the Illinois Society of Engineers held at Urbana, January 6, 1928.

H. B. Roe, associate professor of agricultural engineering, University of Minnesota, is joint author with G. E. Smith and W. D. Reeve, professors of mathematics, Teachers College, Columbia University, of a new book, entitled "Mathematics for Agriculture and Elementary Science," the purpose of which is to supply the practical mathematics needed in elementary college courses in the sciences, with particular emphasis upon the needs of students of agriculture and forestry. A review of this book will be found on another page in this issue. Prof. Roe is also author of a new bulletin, entitled "An Analysis of the Cost of Tile Drainage Installation on the Farm," recently issued by the Minnesota Agricultural Experiment Station. There is a limited edition of this bulletin, and drainage men who desire it for reference use should make reservation for a copy at an early date.

New A.S.A.E. Members

Abel C. Bennett, associate mechanical engineer, U. S. Department of Agriculture, Tallulah, La.

Harriet C. Brigham, instructor in home economics, Iowa State College, Ames, Ia.

Benjamin Brown, manager, Utah Poultry Producers Cooperative Assn., New York City.

Dave E. Darrah, advertising manager, Hart-Parr Company, Charles City, Ia.

Douglas N. Graves, vice-president, New Holland Corporation, New Holland, N. C.

Burton S. Harris, chief engineer, Massey-Harris Co. Ltd., Toronto, Canada.

Charles F. Miller, agricultural engineer, National Lumber Manufacturers Assn., Chicago, Ill.

R. C. Rolfing, vice-president, Hart-Parr Company, Charles City, Ia.

Dan A. Wallace, editor, Webb Publishing Co., St. Paul, Minn.

Carl Williams, editor, Oklahoma Farmer-Stockman, Oklahoma City, Okla.

Wilbert C. Wood, assistant professor, University of Saskatchewan, Saskatoon, Canada.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the January issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Howard T. Greene, treasurer, Brook Hill Farm, Genesee Depot, Wis.

Neal D. Herrick, sales engineer, The Edison Electric Illuminating Co., Boston, Mass.

Roy H. Kipp, designer, International Harvester Co., Chicago, Ill.

Ernest L. Kleckner, instructor, West Central School, Morris, Minn.

Archie R. Loyd, rural service engineer, Kansas Gas and Electric Co., Wichita, Kan.

Edward H. Matthews, assistant manager, H. W Caldwell & Son Co., Chicago, Ill.

Harry Miller, instructor in agricultural engineering, University of Saskatchewan, Saskatoon, Sask., Canada.

Hickman Price, wheat grower, 420 Madison Avenue, New York City.

G. Arthur Rietz, sales training work, General Electric Co., Schenectady, N. Y.

E. W. Symns, Ingersoll, Okla.

Employment Bulletin

This service, conducted by the American Society of Agricultural Engineers, appears regularly in each issue of AGRICULTURAL ENGINEERING. Members of the Society in good standing will be listed in the published notices of the "Men Available" section. Nonmembers as well as members, are privileged to use the "Positions Open" section. Copy for notices should be in the Secretary's hands by the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. No charge will be made for this service.

Men Available

AGRICULTURAL ENGINEER available. Seventeen years experience in the designing and manufacture of farm tractors, motor trucks, harvesting machines, and earth-working tools. Sales experience in United States, Canada, England, France, and Italy. Write for interview. MA-132.

AGRICULTURAL ENGINEER, graduate of Cornell University, with some training in electrical engineering and several years experience electrical work, including power and rural telephone, wants position with electric power company or large agricultural development as agricultural engineer. Experienced in college teaching and extension work and as field expert by a large farm machinery manufacturer. Diplomatic with farmers. Location in East preferred. MA 143.

AGRICULTURAL ENGINEER, graduate in agricultural engineering, (B.S. in 1923; M.S. in 1924) desires position in experimental research work. Two years experiment station experience, five years industrial shop experience, eighteen months in employ of electric service company, one year teaching. Available upon reasonable notice. Age 27. Married. MA-142.

DESIGNING AND RESEARCH ENGINEER with experience in developing equipment and machinery for commercial field. Several years experience in commercial research. Will undertake specific projects for business desiring the solution of problems in design, performance testing, or engineering analysis. MA-145.

MECHANICAL ENGINEER with fifteen years experience in heavy line power farming and harvesting machinery, such as tractors, threshers, combines, and corn pickers and huskers, including ten years as chief engineer, desires employment with reliable and substantial manufacturer of farm equipment. Will go anywhere. MA-146.

AGRICULTURAL ENGINEER, graduate of Iowa State College, with two years experience with the division of agricultural engineering, U. S. Department of Agriculture; two years as engineer officer during war; eight years in charge of reclamation and handling of peat and cutover lands in Minnesota, desires position where this experience will be valuable. Wallace Ashby, Meadowlands, Minn.

EDITOR AND WRITER with ten years experience in farm mechanical equipment, from both trade journal and farm paper angles, specializing on promotion and technique of power farming. Qualified for publication, house organ, advertising literature, or sales promotion work involving technical accuracy and popular appeal. Farm background, college training, instructional experience. W. B. Jones, St. Joseph, Mich.

Positions Open

AGRICULTURAL ENGINEER with ability along experimental and engineering lines wanted by a farm machinery manufacturer in the middle west. Should have training as a draftsman. Recent graduate preferred. PO-130.

EXPERIMENTALIST wanted for experimental department of agricultural implement factory. Young man preferred. Good opportunity for man with ability and desire to learn. PO 131.

AGRICULTURAL ENGINEER with college training and practical experience with tractors, combines, and threshers, wanted by a farm machinery manufacturer in the Middle West. Must be a skilled draftsman and have designing ability. PO-132.

AGRICULTURAL ENGINEER with experience in the designing and drafting of farm structures, including dairy barns, poultry houses, and hog houses, wanted by a manufacturer of farm building equipment in the Middle West. PO-133.

THREE ENGINEERS with several years experience in tractor design wanted by old established tractor manufacturer. Interested persons should explain experience fully, salary expected, etc. PO-134.

U. S. CIVIL SERVICE OPENING

The U. S. Civil Service Commission announces an open competitive examination for junior engineers ($1860 a year) in nine branches, including agricultural engineering. The work includes routine testing and inspection, field work, and work on minor projects, assisting in the conduct of research tests, compiling reports, and handling technical correspondence. Applicants should apply for Form 2600, stating title of examination desired, to the U. S. Civil Service Commission, Washington, D. C. Applications must be on file with the U. S. Civil Service Commission at Washington, D. C. not later than February 25, 1928. The date for assembling of competitors will be stated on their application cards, and will be about ten days after the close of receipt of applications.